# DOCUMENT RESUME

ED 148 645 SE 023 802

TITLE National Water Quality Inventory, 1975 Report to Congress.
INSTITUTION Environmental Protection Agency, Washington, D.C. Office of Water Programs.
REPORT NO EPA-440/9-75-014
PUB DATE 75
NOTE 152p.; For related document, see SE 023 803

EDRS PRICE MF-$0.83 HC-$8.69 Plus Postage.
DESCRIPTORS Chemical Analysis; Cost Effectiveness; *Environment; Environmental Influences; *Pollution; *Public Health; Rural Urban Differences; State Surveys; *Water Pollution Control; Water Resources

ABSTRACT

This document summarizes state submissions and provides a national overview of water quality as requested in Section 305(b) of the 1972 Federal Water Pollution Control Act Amendments (P.L. 92-500). This report provides the first opportunity for states to summarize their water quality and to report to EPA and Congress. Chapters of this report deal with Current Water Quality Conditions, Recent Trends in Water Quality, Major Pollution Problems, Future Program Emphasis, and Costs and Benefits of Achieving the 1983 Goals. Numerous tables and figures are provided to supplement the text. Additionally, the Appendices provide reference information concerning the National Water Quality Surveillance System (NWQSS), the National Eutrophication Survey (NES), and State Agency Addresses. (CS)

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# NATIONAL WATER QUALITY INVENTORY

## 1975 Report to Congress

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SE 023 802

OFFICE OF WATER PLANNING AND STANDARDS
WASHINGTON, D.C. 20460

## This report was prepared pursuant to Section 305(b) of PL 92-500, which states:

"(b) (1) Each State shall prepare and submit to the Administrator by January 1, 1975, and shall bring up to date each year thereafter, a report which shall include—

"(A) a description of the water quality of all navigable waters in such State during the preceding year, with appropriate supplemental descriptions as shall be required to take into account seasonal, tidal, and other variations, correlated with the quality of water required by the objective of this Act (as identified by the Administrator pursuant to criteria published under section 304(a) of this Act) and the water quality described in subparagraph (B) of this paragraph;

"(B) An analysis of the extent to which all navigable waters of such State provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water;

"(C) an analysis of the extent to which the elimination of the discharge of pollutants and a level of water quality which provides for the protection and propagation of a balanced population of shellfish, fish, and wildlife and allows recreational activities in and on the water, have been or will be achieved by the requirements of this Act, together with recommendations as to additional action necessary to achieve such objectives and for what waters such additional action is necessary;

"(D) an estimate of (i) the environmental impact, (ii) the economic and social costs necessary to achieve the objective of this Act in such State, (iii) the economic and social benefits of such achievement, and (iv) an estimate of the date of such achievement; and

"(E) a description of the nature and extent of nonpoint sources of pollutants, and recommendations as to the programs which must be undertaken to control each category of such sources, including an estimate of the cost of implementing such programs.

"(2) The Administrator shall transmit such State reports, together with an analysis thereof, to Congress on or before October 1, 1975, and annually thereafter.

United States
Environmental Protection Agency
Washington, D.C. 20460

The Administrator

Dear Mr. President:
Dear Mr. Speaker:

I am pleased to transmit the National Water Quality Inventory Report for 1975, as required by Section 305(b) of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). It is the second in a series of reports prepared by EPA in cooperation with the States and other Federal agencies. It includes this year, for the first time, reports from the States and other jurisdictions of the United States. Reports from all but three States have been received and are being transmitted.

The report provides an initial assessment of the overall extent of water pollution. Despite reported improvements, many severe problems exist, especially in populated areas. However, 23 out of the 32 States which attempted an overall evaluation report that, even with these problems, most of their waters are of good quality or already meet the 1983 goals of the Act.

The report also gives an indication of the progress of cleanup efforts. From the State reports, and from our own analyses, it appears that we are achieving notable results in cleaning up the major pollution problems stemming from municipal and industrial point source discharges. For instance, our study last year of 22 major rivers showed improvements in oxygen-demanding loads and coliform bacteria, both of which have been the focus of our point source control programs. This year, the States generally confirm these improvements, and some of them also report reduced levels of certain harmful chemicals because of controls on industrial discharges.

At the same time, our studies show (and several States confirm) a worsening situation with regard to nutrients, the substances which can trigger accelerated aging of lakes and estuaries. In about three-fourths of the 22 rivers studied last year, nitrogen and phosphorus nutrient levels were increasing. Out National Eutrophication Survey showed that phosphorus concentrations in 73 percent of 298 eastern lakes surveyed are high enough to cause eutrophication problems. The State reports also express concern about eutrophication. The causes of the eutrophication problem are not easily correctable, even with the authorities available in the 1972 Act, because they usually involve urban and rural runoff as well as dissolved components of sewage effluent. These problems, together with other nonpoint source problems, are a major focus of the second phase (1977-1983) pollution control effort.

The States raise a number of questions which EPA and Congress should address with regard to the 1983 goals expressed in the 1972 Act:

- Several States consider the 1983 goal of fishable and swimmable water wherever attainable to be unrealistic for some waters. For those waters the reduction of pollution to the levels required to meet the goal is said to be either technologically or economically infeasible.
- For certain drainage areas, some States report that the costs of making waters fishable and swimmable may greatly outweigh the benefits. This is especially true in areas where the water is primarily used for irrigation.
- Several States believe current Federal funding levels for municipal treatment facilities are insufficient to meet the 1983 goals. EPA believes that major administrative problems in obligating construction grant funds have been solved.

I commend this report to your attention, particularly for the background information it provides as we jointly review the Federal legislative basis for water pollution control efforts. We also look forward to next year's report, which should provide an improved basis of information from the States, and more detailed technical analyses of national pollution problems.

Sincerely yours,

Russell E. Train

Honorable Nelson A Rockefeller
President of the Senate
Washington, D.C. 20510

Honorable Carl B. Albert
Speaker of the House of Representatives
Washington, D.C. 20515

# Acknowledgement

The major portion of this report is based on the submissions from 47 of the 50 States and from six other jurisdictions of the United States. The Environmental Protection Agency greatly appreciates the time and effort expended by the State and local agencies and by regional commissions such as the Ohio River Valley Water Sanitation Commission, the Interstate Sanitation Commission, and the Interstate Commission on the Potomac River Basin in preparing their reports.

The following individuals from EPA also made significant contributions during the preparation of this report: William Butler, William Nuzzo (Region I); Patrick Harvey, Sal Nolfo (Region II); William O'Neal (Region III); John Hagan (Region IV); Chris Potos (Region V); Roger Hartung (Region VI); Dale Parke (Region VII); Patrick Godsil (Region VIII); Thomas Jones (Region IX); Robert Coughlin, Richard Bauer (Region X); and others in EPA's regional offices; Robert Arvin, Jane Baluss, James Berlow, Arnold Edelman, Susan Frederick, Frederick Leutner, Adelaide Lightner, Alexander McBride, John Richey, William Robertson, and Phillip Taylor, Monitoring and Data Support Division; King Boynton, William Chisholm, Henry Cooke, Jeffrey Goodman, Walter Groszyk, David Lincoln, Susan Mertz, Mary Nolan, and Michael Steinitz, Water Planning Division; Robert Payne, Office of Research and Development; Jack Gakstatter, Environmental Research Laboratory, Corvallis, Oregon; and others too numerous to mention who were, nevertheless, instrumental in contributing to the final product.

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# Executive Summary

## Scope

This report, the second in the series of *National Water Quality Inventory* reports, was prepared jointly by the U.S. Environmental Protection Agency (EPA) and by 47 of the 50 States and six other jurisdictions of the United States. The submissions from the States and other jurisdictions, which were prepared for the first time this year, are being transmitted to Congress in their entirety under separate cover. This report summarizes the State submissions (with one exception which was not received in time for inclusion) and provides a national overview of water quality. The report was prepared pursuant to Section 305(b) of the 1972 Federal Water Pollution Control Act Amendments (Public Law 92-500) (see inside front cover).

This report represents the first opportunity for the States to summarize their water quality and report on related programs to EPA and the Congress. Most States provided useful reports. As an initial effort, however, there are inevitable gaps in the information provided. Future submissions should expand the comprehensiveness of the report coverage.

The State information was supplemented by two studies performed by EPA:

- An analysis of data from the National Water Quality Surveillance System (NWQSS), a nationwide stream monitoring network of 188 stations.

- A summary of results from the National Eutrophication Survey (NES), which analyzed conditions in 812 lakes in 48 States.

## Summary

### *Current Water Quality Conditions*

Despite reported improvements, many severe problems still exist, especially in highly populated areas. The parameters most frequently mentioned as being problems are dissolved oxygen (46 out of 52 reports analyzed), coliform bacteria (45 out of 52 reports), and nutrients (43 out of 52 reports). The NWQSS analysis (Chapter V) indicates significant numbers of observations outside criteria limits for all the parameters mentioned above with the exception of dissolved oxygen, where the criterion used was less stringent than most of the State standards. The NES summary (Chapter VI) shows that phosphorus concentrations in 73 percent of the 298 eastern lakes surveyed are high enough that symptoms of eutrophication would be expected. However, 23 of the 32 States which attempted an overall evaluation reported that even with these problems, most of their waters were of good quality or already met the 1983 goals of the Act.

### *Recent Trends in Water Quality*

Last year, EPA concluded in the 1974 *National Water Quality Inventory* report that the pollutants receiving widespread control (such as oxygen-demanding loads and coliform bacteria) were showing nationwide improvement, while the nutrient parameters (nitrogen and phosphorus) were showing worsening trends. This year, the State reports generally agree with these conclusions, although several also noted improvements in nutrient levels. The improvements for all parameters were attributed to the implementation of control measures by municipal and industrial dischargers. In addition, some States reported reduced levels of certain harmful chemicals because of controls on industrial discharges.

### *Major Pollution Problems*

The major pollution problems and their sources vary with geographical location and land use.

- The Northeastern and Great Lakes States report that their problems with low dissolved oxygen, high nutrient concentrations, and excess coliform bacteria are primarily due to municipal and industrial sources, including urban runoff. The central and southwestern States generally identified sources such as agricultural runoff as the major causes of these problems.
- The central and southwestern States identified turbidity and salinity as particular problems, while industrial States around the Great Lakes reported problems from chemical wastes.
- Waters in several areas of the country were of poor quality due to natural conditions. Many central and southwestern States report high background levels of salinity and turbidity, while several southern States describe low dissolved oxygen levels due to swamp conditions.

The NWQSS analysis generally supports the conclusions with regard to land use, showing higher levels of fecal coliform bacteria and nutrients in areas with high municipal/industrial activity, and higher nutrient levels in areas with high agricultural activity. The NES summary also indicates high nutrient runoff from agricultural areas, and significant phosphorus loadings from municipal effluents. Some of the high nutrient loadings from agricultural areas probably are due to naturally fertile soil conditions in those areas.

### *Future Program Emphasis and 1983 Goals*

The States generally agreed on the need for increased emphasis to control both urban and rural runoff, the primary concerns for most States which expected some of their waters would not attain the 1983 goals of the 1972 Act.

### *Costs and Benefits of Achieving 1983 Goals*

None of the States was able to conduct a quantitative analysis of the costs versus the benefits of water quality programs. However, eight States conclude from qualitative analyses that the large expenditures required to meet the effluent limitations imposed by the 1972 Act cannot be justified in certain areas because the effluent reductions would not noticeably improve water quality in those areas. Also, three States propose that expenditures to make the waters suitable for fishing and swimming should not be required for streams used primarily for irrigation.

Most States provide estimates for the costs of municipal wastewater treatment, and 13 of them also estimate industrial control costs. Ten of the 13 States estimating industrial costs reported those costs to be less than 25 percent of their municipal treatment costs.

# Chapter I

# Current Water Quality and Recent Trends

The 1974 *National Water Quality Inventory* report to Congress studied water quality conditions and trends for 22 of the nation's major rivers, which were divided into 36 segments. This year, each State prepared an analysis of its own waters. This report represents a summary of the State analyses.

## Summary

Despite recent improvements, many severe problems still remain. However, 23 of the 32 States which attempted an overall evaluation reported that, even with these problems, most of their waters were of good quality or already met the 1983 goals.

The 1974 report concluded that oxygen demanding loads and coliform bacteria levels were improving, even though significant problems did remain. The report also concluded that nutrient levels were increasing across the country. The 1975 report shows that the States in general agree with those conclusions, although several report improvements in nutrient levels. In addition, some States noted improvements in the levels of certain harmful chemicals from industrial wastes.

An evaluation of the State reports leads to the following general conclusions for the major pollutant categories.

- Levels of harmful substances such as heavy metals and various chemical compounds have improved in some areas as a result of municipal and industrial waste treatment. However, significant problems from heavy metals and harmful chemicals still exist, primarily in the industrial States in the Northeast and around the Great Lakes. Also, several central and southern States report problems from pesticides.
- Some western and southern States have reported increases in temperature and turbidity from stream modifications for flood control and irrigation.
- Most States report high levels of phosphorus and nitrogen indicating eutrophication potential. In addition, the nutrient parameters were the only ones for which a significant number of States report worsening trends, although a larger number do cite improvements.
- Mining areas across the country reported problems with acid mine drainage. High salinity levels from various sources were also reported for many areas.
- Many States noted improvements in dissolved oxygen levels over the last five years, although almost all States did report that their water quality standards for dissolved oxygen were violated in some areas.
- Almost all States also listed health hazards as indicated by high coliform bacteria counts as a significant problem. Excess coliform bacteria levels caused by municipal discharges have been reduced in many States following installation of adequate treatment facilities.

## Water Quality Conditions and Trends

All of the States report at least one type of water pollution within their borders, and most of them have problems with several different pollutants. The most widely discussed problems were low dissolved oxygen levels (46 of 52 reports), health hazards from excessive coliform bacteria counts (45 of 52 reports), and high nutrient concentrations (43 of 52 reports) (Table I-1). Other widespread pollution conditions may exist, but would not be noted by as many States because the parameters used to identify those conditions were not as widely monitored (Table I-2).

Despite these widespread problems, 23 of the 32 States which attempted an overall evaluation reported that most of their waters are of good quality or already meet the 1983 goals of the Act (Table 1-3).

## TABLE I-1

## WATER QUALITY PROBLEM AREAS REPORTED BY STATES*
Number Reporting Problems/Total

| | Middle Atlantic, Northeast | South | Great Lakes | Central | Southwest | West | Islands | Total |
|---|---|---|---|---|---|---|---|---|
| Harmful substances | 6/13 | 6/9 | 5/6 | 4/8 | 4/4 | 2/6 | 3/6 | 30/52 |
| Physical modification | 7/13 | 3/9 | 3/6 | 8/8 | 3/4 | 6/6 | 5/6 | 35/52 |
| Eutrophication potential | 11/13 | 6/9 | 6/6 | 8/8 | 2/4 | 6/6 | 4/6 | 43/52 |
| Salinity, acidity, alkalinity | 3/13 | 6/9 | 2/6 | 6/8 | 4/4 | 4/6 | 2/6 | 27/52 |
| Oxygen depletion | 11/13 | 9/9 | 6/6 | 6/8 | 4/4 | 6/6 | 4/6 | 46/52 |
| Health hazards | 11/13 | 8/9 | 5/6 | 8/8 | 3/4 | 5/6 | 5/6 | 45/52 |

*Localized or statewide problems discussed by the States in their reports.

Middle Atlantic, Northeast:

Connecticut
Delaware
District of Columbia
Maine
Maryland
New Hampshire
New Jersey
New York
Pennsylvania
Rhode Island
Vermont
Virginia
West Virginia

South:

Alabama
Arkansas
Florida
Georgia
Kentucky
Louisiana
North Carolina
South Carolina
Tennessee

Great Lakes:

Illinois
Indiana
Michigan
Minnesota
Ohio
Wisconsin

Central:

Colorado
Iowa
Kansas
Montana
Nebraska
North Dakota
South Dakota
Wyoming

Southwest:

Arizona
New Mexico
Oklahoma
Texas

West:

California
Idaho
Nevada
Oregon
Utah
Washington

Islands:

American Samoa
Guam
Hawaii
Puerto Rico
Trust Territories
Virgin Islands

## TABLE 1-2

### WATER QUALITY PARAMETERS COMMONLY MONITORED BY STATES*

| Parameter | Number of states |
|---|---|
| Flow | 47 |
| Dissolved oxygen | 47 |
| Coliform bacteria | 45 |
| Nitrogen (any form) | 39 |
| Phosphorus (any form) | 35 |
| pH | 35 |
| BOD/COD/TOC | 27 |
| Water temperature | 29 |
| Turbidity | 26 |
| Solids (any type) | 27 |
| Metals (any type) | 17 |
| Chlorides | 19 |
| Alkalinity | 15 |
| Conductivity | 16 |
| Color | 11 |
| Sulfate | 14 |

*Only parameters specifically mentioned as being part of the State's monitoring program are counted. Only parameters listed by at least 10 States are included.

## TABLE 1-3

### OVERALL WATER QUALITY EVALUATIONS BY STATES

| | Number of States |
|---|---|
| Most waters now meet 1983 goals | 10 |
| Most waters are of good quality | 13 |
| Most waters do not meet goals | 9 |
| No overall evaluation made | 20 |
| | 52 |

The parameters which had the most widespread problems were also the ones where the largest number of States noted improvements. Nineteen States noted improvements in dissolved oxygen levels while 16 reported lower coliform bacteria levels and 10 reported lower nutrient levels (Table 1-4). However, five States noted worsening trends for nutrients, the only parameters for which any significant degradations were noted. Finally, four States noted improved levels of harmful substances, primarily because of controls on industrial dischargers.

### *Harmful Substances*

The presence of heavy metals in the waters of the highly urbanized and industrialized areas of the Northeast and Great Lakes regions is a serious problem because of the detrimental effects these metals can have on various forms of aquatic life. Industrial discharges from a variety of manufacturing plants and urban runoff seem to be primarily responsible for these high concentrations. Unacceptable heavy metal concentrations are also reported in some parts of the West as a result of mining operations. The metals most frequently mentioned as presenting a problem are mercury, cadmium, manganese, lead, and iron.

Although some improvements have been reported, unacceptable levels of harmful chemical wastes from industrial processes and of pesticides remain a problem in many States, with the Northeast and Great Lakes areas being primarily concerned with industrial wastes, and the central and southern States having problems with pesticides. Polychlorinated biphenols (PCB's) and phenols from industrial wastes and pesticides such as DDT and dieldrin have forced several States to limit the consumption of fish from some of their waters.

Concentrations of un-ionized ammonia which can be harmful to fish present a problem in many areas of the country, especially during low flow conditions. In addition to industrial sources, many older secondary treatment plants do not provide enough ammonia reduction. Thus, when effluent from these treatment plants is a significant portion of the stream flow, ammonia toxicity can pose a threat to aquatic life. Installation of newer treatment facilities is helping to reduce this problem.

Spills of oil and other petroleum products from pipelines and manufacturing plants pose a threat to water quality across the country. Many States are taking action to confront this problem by setting up emergency investigative and cleanup staffs.

Two of the Great Lakes States express concern over the concentrations of asbestos or asbestos-like fibers, which may be carcinogenic, in portions of Lake Superior used for drinking water supplies. These States report that the fibers are apparently being discharged in the waste from a Reserve Mining Company operation.

## TABLE 1-4

### STATEWIDE WATER QUALITY TRENDS REPORTED BY STATES*
Number Reporting Trend/Number Reporting Problem

| | Middle+ Atlantic, Northeast | South | Great Lakes | Central | Southwest | West | Islands | Total |
|---|---|---|---|---|---|---|---|---|
| **Harmful substances** | | | | | | | | |
| Improving | 2/6 | 0/6 | 1/5 | 1/4 | 0/4 | 0/2 | 0/3 | 4/30 |
| Constant | 4/6 | 6/6 | 4/5 | 3/4 | 4/4 | 2/2 | 3/3 | 26/30 |
| Degrading | 0/6 | 0/6 | 0/5 | 0/4 | 0/4 | 0/2 | 0/3 | 0/30 |
| **Physical modification** | | | | | | | | |
| Improving | 2/7 | 0/3 | 0/3 | 1/8 | 0/3 | 0/6 | 1/5 | 4/35 |
| Constant | 5/7 | 3/3 | 3/3 | 7/8 | 3/3 | 6/6 | 4/5 | 31/35 |
| Degrading | 0/7 | 0/3 | 0/3 | 0/8 | 0/3 | 0/6 | 0/5 | 0/35 |
| **Eutrophication potential** | | | | | | | | |
| Improving | 4/11 | 0/6 | 2/6 | 2/8 | 0/2 | 2/6 | 0/4 | 10/43 |
| Constant | 5/11 | 5/6 | 3/6 | 5/8 | 2/2 | 4/6 | 4/4 | 28/43 |
| Degrading | 2/11 | 1/6 | 1/6 | 1/8 | 0/2 | 0/6 | 0/4 | 5/43 |
| **Salinity, acidity, alkalinity** | | | | | | | | |
| Improving | 0/3 | 0/6 | 0/2 | 0/6 | 0/4 | 0/4 | 0/2 | 0/27 |
| Constant | 3/3 | 6/6 | 2/2 | 5/6 | 4/4 | 3/4 | 2/2 | 25/27 |
| Degrading | 0/3 | 0/6 | 0/2 | 1/6 | 0/4 | 1/4 | 0/2 | 2/27 |
| **Oxygen depletion** | | | | | | | | |
| Improving | 9/11 | 2/9 | 3/6 | 3/6 | 0/4 | 1/6 | 1/4 | 19/46 |
| Constant | 2/11 | 7/9 | 3/6 | 3/6 | 4/4 | 5/6 | 3/4 | 27/46 |
| Degrading | 0/11 | 0/9 | 0/6 | 0/6 | 0/4 | 0/6 | 0/4 | 0/46 |
| **Health hazards** | | | | | | | | |
| Improving | 9/11 | 2/8 | 1/5 | 3/8 | 0/3 | 1/5 | 0/5 | 16/45 |
| Constant | 2/11 | 6/8 | 4/5 | 5/8 | 3/3 | 4/5 | 5/5 | 29/45 |
| Degrading | 0/11 | 0/8 | 0/5 | 0/8 | 0/3 | 0/5 | 0/5 | 0/45 |

*Only States indicating a water quality problem area in Table I-1 are considered in that category for Table 1-4. Improvement, constancy, or degradation are listed as specifically discussed on a Statewide basis in each State report. A constant condition was assumed when a water quality problem was discussed but a statement of the Statewide trend was omitted.

+ Same groupings as in Table I-1.

### *Physical Modification*

The effects of physical modifications to streams are evident in many areas of the Nation. Temperature alterations are reported to be a major problem in many areas, especially the West, with the primary causes being the withdrawal and discharge of water for irrigation and industrial cooling, and the impoundment and release of water at dams. The heated water can severely affect biological communities.

Turbidity problems which can reduce the light penetration necessary for adequate aquatic plant growth exist in almost every State. In some cases the turbidity is considered to be natural, while in many cases runoff due to human activities is suspected, if not confirmed, to be the cause of the problem. The runoff is from urban areas, farmlands, and from logging and mining operations. Other sources of turbidity include municipal and industrial discharges.

Summer flow reductions due to impoundments have resulted in elevated temperatures and low dissolved oxygen levels in several western States. The reduction in the dilution capacity of the streams also pushed nutrient and organic material concentrations to unacceptable levels in several cases.

Some western and southern States report that stream channel alterations caused by dredging and bank modifications affect the velocity of flow in the stream. The permanance of such changes offers very little chance for improvement of their detrimental effects, which include increased temperature and turbidity.

Interference with the spawning activities of migratory fish caused by dams constructed for power production and flow control is reported in the west. Some improvement has been noted as various remedies for this problem have been found.

In general, the most prevalent problems in this category, elevated temperature, high turbidity, and flow reduction persist because of the permanence of large public works projects and the difficulty and expense of controlling sediment loads from runoff. Many States are trying to improve this facet of their water quality, but few reported significant successes.

### *Eutrophication Potential*

The data provided by several States show eutrophication potential, which is the potential for accelerated aging of lakes and streams, to be increasing at a noticeable rate. Localized improvements have been made through improved phosphorus and nitrogen removal processes at various municipal treatment plants. However, municipal effluents remain one of the primary sources of these nutrients because of the difficulties in removing them from wastewaters. Combined sewer overflows and runoff from urban areas also contribute to eutrophication potential. In nonurban areas the States point to agricultural runoff of fertilizers, discharges from feedlots, and leached nutrients from septic tanks as major sources contributing to increased eutrophication potential.

The results of high eutrophication potential are noticeable. Fish kills can often be traced to algal depletion of oxygen. Algal slimes and nuisance odors have been reported in many areas. The States are seeking to reduce this degradation, but measures required for control are often expensive and difficult to implement. Another obstacle is that the concentrations of certain nutrients, especially phosphorus, required to stimulate massive algal growth are so small that it is often difficult to identify and control the source or sources. Some States report that eutrophication problems may have been somewhat neglected in the past in favor of other serious problems more readily solved.

### *Salinity, Acidity, and Alkalinity*

Salinity, acidity, and alkalinity are reported at unacceptable levels in several States. Salinity problems are found in some coastal areas because of saltwater intrusions resulting from increased industrial, agricultural, and municipal consumption of surface and groundwaters or from excessive drainage of freshwater recharge areas. The disposal of brines from oil fields is an important contribution to the salinity of the water in numerous southern and western States. The central and western States are also confronted with the problem of irrigation return flows and runoff carrying large quantities of salt from agricultural lands, while States in colder climates mention highway deicers as a significant source. Since solutions to the salinity problem are not always economically acceptable, progress in this category has been very slow.

Acidity is a source of water quality degradation in the industrial northeastern States as well as in mining areas located in many other parts of the Nation. The industrial sources of acidity have shown improvement in recent years, while runoff from mining areas has continued to be a serious problem.

Excessive alkalinity occurs in several areas of the Southwest. This alkalinity usually can be traced to groundwater and runoff flow through natural alkaline deposits. However, some excess alkalinity is being contributed by irrigation activities in this region. Due to the fact that the problem is largely a result of natural conditions, very little can be done about it. Also, very little control over alkalinity from irrigation return flows has been undertaken to date.

### *Oxygen Depletion*

Depletion of oxygen from surface waters has historically been one of the most widely noted water quality problems. This concern is because fish require certain minimum levels of dissolved oxygen to survive. Most States reported violations of dissolved oxygen standards for one or more stream segments.

The sources of oxygen-demanding materials leading to reductions in dissolved oxygen levels are numerous. Municipal and industrial discharges are a major source of BOD (biochemical oxygen demand) and COD (chemical oxygen demand) loads. The reduction of dissolved oxygen levels caused by combined sewer overflows is reported for most large urban areas, especially in the densely populated areas of the Northeast and around the Great Lakes where the sewer systems are older. The completion of a large number of municipal construction projects and the issuance of discharge permits to industrial polluters have resulted in significant improvements in dissolved oxygen levels over the last five years. However, many problems related to point sources still remain.

Runoff from cities and agricultural areas deposits large quantities of oxygen-demanding materials in streams. Development of economically feasible control techniques for these sources has been difficult, and abatement efforts have proceeded very slowly.

Physical modification of streams and lakes has also helped to reduce dissolved oxygen levels. Decreased flow rates result in reduced turbulence which in turn decreases the reaeration rate of the water. Also, increased temperature will lower the saturation concentration of oxygen in the water, which results in a reduction of the dissolved oxygen available to biochemical and chemical demand. These problems are also especially difficult to correct.

### *Health Hazards*

Health hazards in the form of infectious pathogens are generally assumed to be present when evidence of animal fecal matter as measured by fecal coliform bacteria is found in the water. While these pathogens can be removed from drinking water supplies by chlorination, their presence in surface waters can make those waters unfit for contact recreation. The presence of potential health hazards based on excessive coliform bacteria counts is listed in almost all State reports. Significant sources of bacteria which are coming under control include poorly treated or untreated effluents from municipal outfalls and, to a lesser degree, runoff from livestock feedlots. Improvements in water quality due to these controls have already been noted in many areas.

Other sources of bacterial contamination which are more difficult to identify and control include runoff from urban and rural areas, and in some cases, contamination of groundwaters from septic tank drain fields.

## Monitoring and Reporting Procedures

The State water quality assessments are primarily concerned with determining water uses relative to the 1983 goals of PL 92-500 and do not generally discuss drinking water problems, except for some descriptions of groundwater contamination. The reports also provide very little information on marine water quality, except for some discussions of shellfish harvesting areas.

The State monitoring programs vary in complexity from very limited parameter coverage in States with recently implemented programs to highly comprehensive monitoring procedures, including bioassays, in those States with more experience in this field. Dissolved oxygen and flow are measured by almost all States, while coliform bacteria, nitrogen, phosphorus, pH, oxygen demand, and water temperature are monitored in more than half the States (Table 1-2). A few States did not mention any specific parameters. The monitoring schedule used by most States consists of monthly samples taken at fixed stations throughout the year, weather and flow conditions permitting. Almost every State reports a need for increased monitoring to help identify specific pollution sources in problem sreas, but most of them feel that the existing programs are adequate enough to provide a relatively accurate assessment of overall water quality.

The reporting procedures used by the States follow five basic patterns, of which one or more was employed by each State (Table 1-5). Aggregation of water quality data by river basin was the most popular procedure. Many States also present river profiles showing variations in water quality parameter values along the length of a stream or stream segment. A third procedure is to identify the specific water quality problem areas in the State. The classification of streams by current and proposed uses for each segment is used by several Northeastern States as the basis for evaluating their current water quality. Finally, five States assess the quality of their waters through the use of three different water quality indexes. Each index is based on a weighted average of selected water quality perameters, with the differences between them being the parameters used and the relative weight assigned to each parameter.

## TABLE 1-5

### DATA REPORTING TECHNIQUES USED BY STATES*

| Technique | Number of states |
|---|---|
| Problem area identification only | 13/52 |
| Use classification (all segments) | 7/52 |
| River profiles for selected parameters and segments | 26/52 |
| Aggregating data by basin | 38/52 |
| Water quality indices | 5/52 |

*A State may use more than one technique.

# Chapter II

# Water Quality Goals

As established in the Federal Water Pollution Control Act Amendments of 1972, the national goal to be achieved by July 1, 1983, wherever attainable, is "water quality which provides for the protection and propagation of fish, shellfish and wildlife, and provides for recreation in and on the water." This goal is a step toward achieving the long-term objective to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The States were asked to report what portion of their waters presently meets the 1983 goal.

While specific definition of the goal in terms of physical, chemical, and biological parameters has not yet been formulated, EPA is in the final stages of preparing water quality criteria, which will define conditions that will allow for different uses, including those prescribed by the 1983 goals.

## Summary

Forty-five States and other jurisdictions report that some portion of their waters will not be able to meet the fishable and swimmable criteria of the 1983 goal. The few States which attempt to estimate what percentage of their waters will not achieve those criteria report that, in terms of stream miles or number of stream segments, less than 10 percent of their waters will not be fishable and swimmable. Furthermore, an undetermined portion of the waters not projected to meet the goal will satisfy part of it—most often providing for protection and propagation of fish and wildlife, although not allowing contact recreation.

The States listed point sources, nonpoint sources, and administrative problems (including funding) as reasons for not meeting the 1983 goals. This discussion uses the terms "point source" and "nonpoint source" in the same context as most of the States used them. The terms are descriptive and do not imply any legal categorization of various sources. The northeastern and Great Lakes States had the most problems with point sources, especially urban runoff, while most of the other States listed nonpoint sources as the primary reasons for not being able to attain the 1983 goals. Insufficient funding and administrative delays caused by requirements of the Act and EPA were cited by several States as other reasons why the goals of the Act could not be met, at least by 1983. Twenty-one States reported that some waters cannot be made fishable and swimmable because of natural conditions.

Current pollution control efforts are primarily concerned with point source abatement through issuance of discharge permits to municipal and industrial dischargers and the awarding of municipal construction grants. For the future, the States believe more emphasis should be placed on controlling nonpoint sources.

Policy issues raised by the States include: Federal funding levels, lack of definition of the 1983 goals, and the appropriateness of uniform effluent standards and of the 1983 water quality goals for all waters.

## National Attainment of 1983 Goals

Forty-five States reported that some of their water would not be able to meet the 1983 goal of the Act. The reasons for the Nation's projected failure to completely achieve fishable and swimmable waters by 1983 lie in four main categories (Table II-1). They are: point sources (30 States), nonpoint sources (37 States), natural conditions (21 States), and administrative problems (20 States).

### *Point Sources*

Thirty State reports claim that some waterways within their State would violate the 1983 goal because of point source pollution, either from urban stormwater runoff released through storm or combined sewer systems, or from municipal and industrial discharges.

Combined sewer overflows are a problem

## TABLE II-1

## REASONS CITED BY STATES FOR NOT ATTAINING 1983 GOAL

| State | Point sources | Nonpoint sources | Natural conditions | Administrative problems |
|---|---|---|---|---|
| Alabama | X | X | X | |
| Arizona | X | X | X | |
| Arkansas | X | X | X | X |
| Colorado | X | X | X | |
| Delaware | X | | X | |
| District of Columbia | X | | | X |
| Florida | X | X | X | X |
| Georgia | X | X | X | |
| Guam | X | X | | |
| Hawaii | | X | | |
| Illinois | X | X | | X |
| Indiana | X | X | X | |
| Iowa | | X | | |
| Kansas | | X | X | X |
| Kentucky | X | | | X |
| Maine | X | | | |
| Maryland | X | X | X | |
| Michigan | X | X | | X |
| Minnesota | | X | | X |
| Montana | X | X | X | |
| Nebraska | X | X | | |
| Nevada | X | X | X | |
| New Hampshire | | X | | |
| New Jersey | X | X | X | |
| New Mexico | | X | X | |
| New York | X | | X | X |
| North Carolina | | X | | |
| North Dakota | X | X | | X |
| Ohio | X | X | | |
| Oklahoma | | X | X | X |
| Oregon | | | | X |
| Pennsylvania | | X | | |
| Puerto Rico | X | | | |
| Rhode Island | | X | | X |
| South Carolina | X | X | | |
| South Dakota | X | X | X | X |
| Tennessee | X | X | | X |
| Texas | X | X | | X |
| Utah | X | X | X | |
| Vermont | | | X | X |
| Virginia | | X | X | |
| Washington | X | X | | X |
| West Virginia | | X | | |
| Wisconsin | X | X | | X |
| Wyoming | | X | X | X |
| Total (45) | 30 | 37 | 21 | 20 |

primarily in the Northeast and around the Great Lakes where the sewer systems are generally older. For example, Illinois reports that 45 percent of the pollution in the Chicago waterways is due to combined sewer overflows. New York State says that combined sewer overflows will be the chief obstacle to attainment of the 1983 goal in certain metropolitan areas. New Jersey states that even after the application of stringent advanced wastewater treatment technology for most sources, combined sewer problems cannot be sufficiently alleviated to achieve water quality goals by 1983.

The Northeast and Great Lakes areas also report that municipal and industrial dischargers will be a major factor in preventing certain stream segments from meeting the 1983 goals, even after installation of wastewater treatment. These stream segments are generally small in comparison to the volume of waste discharged into them. For example, Indiana describes segments of the White River and the Indiana Harbor Canal which, during dry weather periods, have flows composed almost entirely of municipal and industrial effluents. Several southern States also report that complex urban and industrial discharges to small streams will probably result in noncompliance with the 1983 goals.

Although the central States generally regard nonpoint sources as their main reason for nonattainment of the goal, point sources are also a contributing factor. In the South Platte River of Colorado, for example, the 1983 goal will be achieved only with greatly improved control of point source discharges; especially from sewage treatment plants.

Of the western States, Washington alone has included municipal and industrial discharges in specific problem areas as a reason for nonattainment of fishable and swimmable waters by 1983.

### *Nonpoint Sources*

Nonpoint sources and their predicted effects on waterways in 1983 are of concern to 37 States. The main categories of nonpoint sources of pollution discussed by the States are:

- Agricultural activities—including soil erosion and runoff containing nutrients, pesticides, and heavy metals.
- Silvicultural activities
- Mining and acid mine drainage
- Land development and urbanization
- Runoff from abandoned oil fields

In the central States, with their emphasis on agricultural activity, the major reasons for projected noncompliance with the 1983 goal are nonpoint sources. For example, agricultural runoff is expected to interfere with goal achievement in the Missouri River tributaries, the White River and the South Platte River of Nebraska. In Kansas, it is estimated that runoff will cause standards for body contact recreation to be exceeded 30 to 60 percent of the time.

Nonpoint sources of pollution in the northeastern and middle Atlantic States, though not as numerous as in the Midwest, contribute to nonattainment of the goal. For example, the major reasons that some of Maryland's waterways are not meeting the 1983 goal are nonpoint sources such as agricultural runoff and seepage from septic tanks.

Nonpoint source pollution problems in the southern States are associated with agriculture, silviculture, erosion from construction and mining, and acid mine drainage. Uncertainty as to extent, cause, and prevention methods of nonpoint sources and related water quality is an underlying theme in most of the State reports.

Data sufficient to make an accurate quantitative analysis of nonpoint sources of pollution—and the resultant failure of waterways to meet the 1983 water quality goal—are not available from State reports. However, two categories of nonpoint pollution are addressed to some extent: acid mine drainage and runoff from abandoned oil fields, including oil seeps. Specifically, acid mine drainage will cause violations in Illinois, Kentucky, Ohio, West Virginia, Alabama, Colorado, Pennsylvania, and Montana. Low pH readings resulting from past and present mining activities indicate current problems, which are projected to continue through 1983. The Pennsylvania Department of Environmental Resources estimates that approximately one-half of those streams projected not to meet the 1983 water quality goal are affected by abandoned mine drainage.

Runoff from abandoned oil fields and oil seeps are nonpoint sources that will interfere with attainment of the goal in Oklahoma, Texas, and Arkansas. The Red River and its tributaries in these States are affected by oil field runoff due to insufficient control methods. Leaching from oil drilling activities and oil brines causes salt accumulation in the streams, which eventually destroys shoreline habitats.

### *Natural Conditions*

In 21 State reports, natural conditions are cited as a reason for not attaining fishable and swimmable waters (Table II-2). Two different types of situations are described by the States under the term "natural conditions". The first is where conditions which occur without the influence of human activity preclude either recreation in and on the waters or the protection and propogation of fish, shellfish, and wildlife. Some of these conditions are low dissolved oxygen levels in swamps, natural hot springs, toxic metals dissolving from rocks into streams, and naturally high levels of nutrients, turbidity or salinity. Since the Act calls for water quality which provides for fishing and swimming only "wherever attainable", natural conditions which prevent these uses do not in themselves preclude achievement of the overall objective of the Act, which is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."

The second type of situation referred to as a natural condition is where seasonal low flows provide insufficient dilution of wastewaters to allow water quality standards to be met. Since the pollutants are not naturally occurring in these situations, the water quality problems are not due to natural conditions.

### *Administrative Problems*

Administrative problems of varying natures have impeded progress toward meeting the 1983 goal. Twenty States mention that the Act directly interferes with State pollution control efforts and has actually interrupted progress toward cleaner waters. A few States cite problems resulting from what they perceive to be poor organization of the National Pollutant Discharge Elimination System (NPDES). The NPDES program requires all waste dischargers to have both a permit for such activities and a schedule of improvements to be made in effluent quality. EPA has initial responsibility for the permit program. However, where States are able and willing to conduct the permit program, the responsibility has been delegated to them. Though only three States refer directly to problems in executing the NPDES program, other States allude to difficulties in controlling point source effluents. New York listed several areas of difficulty in administering the program: permit issuance problems, missed compliance dates, inadequate data management, and "unenforceable imposed limits issued in haste to beat the clock." Kentucky stresses its inability to police effectively all point source dischargers. (However, at the time their reports were prepared, New York and Kentucky had not

TABLE II-2

NATURAL CAUSES CITED BY STATES
AS REASONS FOR NOT ATTAINING FISHABLE AND SWIMMABLE WATERS

| State | Natural erosion/ siltation | Salinity/ mineralization | Toxic metals | Seasonal low flow | Estuary salinity/ pH | Low DO swamp conditions | Natural eutrophication | Wildlife bacteria | Natural hot springs |
|---|---|---|---|---|---|---|---|---|---|
| Alabama | | | | X | | | | | |
| Arizona | X | | | X | | | | | |
| Arkansas | | | | X | | | | | |
| Delaware | | | | | X | | | X | |
| Florida | | | | | | X | X | | |
| Georgia | | | | | | X | | | |
| Indiana | | | | | | | | X | |
| Kansas | X | X | | | | | | | |
| Maryland | | | | | X | | | | |
| Montana | X | X | X | | | | | | |
| Nebraska | X | X | | | | | | | |
| Nevada | | X | | | | | | | X |
| New Jersey | | | | | X | | | | |
| New Mexico | X | X | | X | | | | | |
| New York | | | X | | | | | | |
| Oklahoma | X | X | | | | | | | |
| South Dakota | X | | | | | | | | |
| Utah | X | X | | X | | | | | X |
| Vermont | | | | | | | X | | |
| Virginia | | | | | | X | | | |
| Wyoming | X | | | | | | | | |
| Total | 9 | 7 | 2 | 5 | 3 | 3 | 2 | 2 | 2 |

assumed responsibility for permit issuance.) Several States refer to the long delays in obtaining permits for effluent discharges and the resulting delays in pollution control efforts.

Many States project that monetary problems will be a severe handicap in attaining the 1983 goal. By law, EPA provides 75 percent of the monies required for approved projects for construction or updating of publicly owned treatment works. The State and/or locality must provide the other 25 percent. States reported fiscal problems on both the Federal and State/local levels with at least six States reporting that the 1983 goal will be attained only if funds for needed planning programs and construction activities are available. Washington and Rhode Island state that achievement of the goal would depend on the availability of municipal construction funds and State grant money. Rhode Island reports having difficulty in raising the local portion of the monies, as the citizens have voted down proposed expenditures for construction or renovation of sewage treatment plants.

Utah cites Federal interference with State programs and legislation, charging that the inefficiency of the grant program has halted construction of many sewage treatment plants for months, thus aggravating pollution problems. Oregon argues that the Federal funds are "conditioned to so many restrictive conditions and regulations that it is very difficult for the State to get the intended job done."

## Control Programs

The Act provides for programs to deal with the control and elimination of both point and nonpoint pollution problems. Point sources of pollution are currently being regulated through NPDES, as called for by the Act. Many States also recently adopted statutes requiring testing and certification of wastewater treatment plant operators in order to assure that their facilities operate efficiently.

Under Phase II (1977-1983) of the program, greater emphasis will be placed on control of nonpoint sources of pollution. The majority of the States anticipate that nonpoint source pollution will be identified and managed as a consequence of the development of areawide and Statewide waste treatment plans under Section 208 of the Act. Additional quantification of nonpoint source pollution will come with implementation of Sections 303(e) and 208(b), which provide for preparation of State Water Quality Management Plans.

Several States have adopted pollution control programs and laws in addition to those provided in the Act. These programs are largely geared toward identification and control of nonpoint sources of pollution. Indiana, for example, undertakes prompt investigation of all pollution complaints, including alleged nonpoint source problems. A follow-up of each confirmed pollution problem results in the enforcement of necessary control measures. Connecticut has implemented a wide variety of nonpoint source control programs dealing with wetlands, special wastes handling, farm wastes (including pesticides), and watercraft pollution. Maryland's 1970 Abandoned Mine Drainage Act provides funding for reclamation of surface mined and orphaned lands. A unique Erosion and Sediment Control Law in Virginia is aimed at controlling erosion on construction sites.

In instances where a river flows through more than one State, the affected States have found it beneficial to conduct joint programs, several of which have been in effect for a number of years. The Delaware River Basin Commission is the result of one such multistate effort. It is charged with monitoring the numerous Delaware River segments and providing detailed assessment data to the concerned States. Similar commissions are in operation on the Potomac and Ohio Rivers. The States containing or bordering the Colorado River have formed the Colorado River Basin Salinity Control Forum, for the purpose of maintaining the river's salinity concentration at or below the 1972 level.

## Issues Raised in State Reports

Several issues have been raised by the States regarding attainment of the 1983 water quality goal. Some of these issues, such as Federal funding levels and appropriateness of the 1983 goals for all waters, have already been introduced. Other issues include lack of definition of the 1983 goal and uniform effluent standards for all dischargers, regardless of receiving water quality.

### *Funding*

Eight States reported that meeting the 1983 goal of the Act is contingent upon future

Federal funding. Both funding levels and availability of funds were cited as possible reasons for not meeting the goal.

EPA has solved major administrative problems in obligating construction grant funds. This is evidenced by the fact that the Agency obligated $3.6 billion in construction grants during fiscal year 1975.

### *Lack of Definition of 1983 Goal*

Eleven States report that EPA has to date given no formal guidance on the definition of water quality which provides for protection and propagation of fish, shellfish, and wildlife and recreation in and on the water where attainable. As a result both misunderstandings and misinterpretation of the 1983 goal have occurred.

Water quality criteria, revised under Section 304(a) of the Act, are in the final stages of review. These criteria will help the States assess the 1983 goals by defining water quality conditions that will allow for different uses. In addition, EPA has published regulations to provide guidance in revising water quality standards.

### *Effluent Limitations and Water Quality*

Eight States assert that effluent limitations required by the Act may be more stringent than necessary to protect water quality; specifically, secondary treatment for municipal facilities or best practicable control technology for industries may not be necessary in all cases to meet the 1983 goal.

Congress, after thorough deliberation, required through the Act that EPA set national technology-based effluent guidelines independent of receiving water quality for municipal treatment facilities and industrial dischargers.

### *Desirability of the 1983 Goal*

Seven States report that they desire parts of their waters to be used primarily for irrigation and as receiving water for industrial waste streams. Where these uses are incompatible with protection and propagation of aquatic life and recreation in and on the water, the States question the desirability of meeting the 1983 goal.

EPA believes that Congress, EPA, and other interested parties should jointly review the desirability of the 1983 goal for all waters using information from the State reports, from the National Commission on Water Quality report, and from other sources.

# Chapter III

# Costs and Benefits of Meeting Water Quality Goals

Assessing the costs and benefits of achieving the 1983 water quality goals of the Act has been a very complex and difficult task. For a complete discussion of EPA's studies, the reader is referred to the *Cost of Clean Water* reports to Congress, and to the annual reports of the Council on Environmental Quality (CEQ). The State reports for the *National Water Quality Inventory* provide at least some rough qualitative assessments of the relationships between costs and benefits for specific areas. In addition, they present some indications of how the costs and economic impact will be distributed across the country.

## Summary

Almost all States attempted to provide at least some qualitative estimates of what the costs and benefits of meeting water quality goals might be. The following general conclusions are drawn from the State discussions:

- The greatest estimates of costs involved in meeting water quality goals are for construction of municipal treatment facilities and controlling urban stormwater problems. The total State reported estimates from the *1974 "Needs Survey"*, which was referenced by most States, was $121 billion for all categories except stormwater control. Stormwater control estimates totalled $235 billion.
- Costs of industrial pollution abatement are estimated to be considerably less than the costs of municipal treatment, even excluding stormwater control, for the great majority of States which provided a basis for comparing the two.
- Costs of controlling what the States identified as nonpoint sources are especially difficult to assess. For eastern States, quantitative estimates for erosion control are considerably lower than estimated municipal costs, while quantitative estimates from the Midwest farm belt States showed erosion control costs to be of the same order of magnitude as municipal costs. Many western States comment that nonpoint source control costs, even though they could not yet be quantified, might be considerably higher than municipal costs. These States generally have comparatively lower municipal facility needs than the eastern States.
- Pollution control benefits are generally said to outweigh costs in most of the States which attempted to compare them. Many of the States which discuss the topic report that, for certain stream segments, the benefits would not be worth the costs of meeting water quality goals. Several western States comment that potential benefits definitely did not justify the costs of controlling runoff in agricultural areas.

## Methodologies

Since most States considered capital investment costs only, all references to costs in this chapter will be limited to investment costs, even though the 1974 CEQ report indicates that over a 10-year period total operating and maintenance costs are almost as high as the investment costs. Another qualification is that the cost estimates supplied by the States for municipal wastewater treatment are of those costs the States project as being necessary to meet all requirements of the Act. If current Federal funding levels are maintained, only about one third of those expenditures will have been made by 1985.

Almost all States provide estimates of municipal wastewater treatment costs very close to those reported in the *1974 "Needs" Survey* report to Congress. The *"Needs" Survey,* prepared by EPA, was conducted to determine municipal costs by State for different categories of wastewater collection and treatment.

Several approaches are utilized to estimate the costs of controlling industrial pollution. They include survey questionnaires, extrapolation of unit costs for municipal treatment to industry, and the use of cost estimates from development documents which were prepared in support of EPA's industrial effluent guidelines. A few

States supply gross estimates without explaining how they are derived. Despite the variety of techniques, only about 25 percent of the States are able to arrive at a total cost estimate for industrial pollution control, although other States do present examples of costs for certain sample plants or for key industries.

The discussions of costs for controlling nonpoint sources are generally not quantitative. A few eastern and midwestern States presented some specific costs for controlling erosion and acid mine drainage. The estimates of erosion control costs are attributed to the Soil Conservation Service. The western States report that they do not know what the costs will be, but they do make qualitative comments concerning the estimated order of magnitude.

## Results of State Analyses

### *Municipal Costs*

Thirty-nine States used their *1974 "Needs" Survey* submissions with some slight modifications as the basis of their cost estimates for municipal wastewater treatment (Table III-1). Eleven States report no complete cost estimates. Of the reports using the *"Needs" Survey* figures, several States believe that the survey overestimates the costs of achieving the requirements of the Act because of overly high projections of tertiary treatment requirements. In addition, there may have been a general tendency to include as many costs as possible because the survey was to be used as an allocation basis for federal construction grants. On the other hand, a few States believe that the survey estimates are low because certain requirements were not considered eligible under the provisions of the *"Needs" Survey.*

Oregon and Montana provide estimates of the costs of the municipal treatment facilities required to meet the water quality goals of the 1972 Act as well as their *"Needs" Survey* estimates. Their assumptions concerning levels of treatment and overall facility requirements are therefore different from those used in the Survey. Montana estimates that $19.5 million would be required for municipal facilities to meet water quality goals. Its *"Needs" Survey* estimate, excluding stormwater control, is $111 million, and its estimate for stormwater control, also from the *"Needs" Survey,* if $625 million. Oregon also reports cost estimates much less than its *"Needs Survey* figures. Its estimate of municipal treatment facility costs to meet water quality goals is $204 million. Its *"Needs" Survey* total, excluding stormwater control, is $1,144 million, and its estimate for stormwater control is $838 million.

TABLE III-1

MUNICIPAL TREATMENT COSTS

("Needs" Survey Categories I-V, Municipal Treatment and Conveyance System Costs; Stormwater Control Excluded)

| | 305(b) Report | "Needs" Survey estimate (1974) | |
|---|---|---|---|
| | | State | EPA |
| | (millions of dollars) | | |
| **REGION I** | | | |
| Connecticut | 1,605 | 1,588 | 1,598 |
| Maine | – | 575 | 589 |
| Massachusetts | – | 2,964 | 3,285 |
| New Hampshire | 820 | 740 | 861 |
| Rhode Island | 516 | 447 | 478 |
| Vermont | – | 204 | 215 |
| **REGION II** | | | |
| New Jersey | 4,610 | 4,894 | 5,010 |
| New York | 17,421 | 15,302 | 17,421 |
| Puerto Rico | 603 | 603 | 604 |
| Virgin Islands | 57 | 44 | 45 |
| **REGION III** | | | |
| Delaware | 548 | 546 | 547 |
| Maryland | 3,911 | 3,642 | 3,932 |
| Virginia | 2,128 | 1,884 | 5,128 |
| West Virginia | 4,225 | 2,360 | 4,225 |
| Pennsylvania | 5,579 | 5,454 | 5,730 |
| District of Columbia | – | 1,052 | 1,053 |
| **REGION IV** | | | |
| Alabama | 819 | 778 | 819 |
| Florida | 3,568 | 2,704 | 3,526 |
| Georgia | 1,584 | 1,519 | 1,595 |
| Kentucky | – | 1,824 | 1,862 |
| Mississippi | – | 494 | 495 |
| North Carolina | 1,531 | 1,480 | 1,531 |
| South Carolina | – | 977 | 1,028 |
| Tennessee | 1,318 | 1,210 | 1,301 |
| **REGION V** | | | |
| Illinois | 6,440 | 6,234 | 6,301 |
| Indiana | 3,004 | 2,903 | 2,968 |
| Michigan | 8,900 | 8,102 | 8,199 |
| Minnesota | 1,335 | 1,330 | 1,387 |
| Ohio | 7,647 | 7,773 | 7,920 |
| Wisconsin | 2,291 | 2,044 | 2,291 |

TABLE III-1 (Continued)

| | 305(b) Report | "Needs" Survey estimate (1974) | |
|---|---|---|---|
| | | State | EPA |
| | (millions of dollars) | | |
| **REGION VI** | | | |
| Arkansas | 1,344 | 898 | 1,503 |
| Louisiana | – | 1,283 | 1,536 |
| New Mexico | 151 | 155 | 156 |
| Texas | 2,982 | 3,222 | 3,752 |
| Oklahoma | 2,000 | 1,484 | 3,664 |
| **REGION VII** | | | |
| Iowa | 990 | 911 | 965 |
| Kansas | 2,086 | 1,783 | 2,348 |
| Missouri | – | 2,298 | 2,399 |
| Nebraska | 924 | 924 | 977 |
| **REGION VIII** | | | |
| Colorado | – | 523 | 716 |
| Montana | 20* | 127 | 128 |
| North Dakota | 204 | 189 | 195 |
| South Dakota | 109 | 75 | 78 |
| Utah | – | 291 | 294 |
| Wyoming | – | 84 | 133 |
| **REGION IX** | | | |
| Arizona | 612 | 500 | 597 |
| California | 6,997 | 6,208 | 7,156 |
| Hawaii | 520 | 523 | 520 |
| Nevada | 316 | 209 | 316 |
| American Samoa | 45 | 52 | 55 |
| Guam | – | 93 | 117 |
| Trust Territories of the Pacific Islands | 190 | 195 | 197 |
| **REGION X** | | | |
| Alaska | – | 405 | 412 |
| Idaho | – | 393 | 471 |
| Oregon | 204* | 1,081 | 1,144 |
| Washington | 2,371 | 1,836 | 2,371 |
| Total | | 107,438 | 121,171 |

*State estimate from "Needs" Survey also reported.

These comments and examples illustrate the difficulties of estimating realistic costs for municipal treatment facilities. The final State estimates as reported by the *"Needs" Survey* for all municipal requirements excluding stormwater control totaled $121 billion. The discussion above suggests that this figure is somewhat high. The combined State estimates for urban stormwater control is even higher, $235 billion. However, despite some exceptions such as the State of Washington, very few States believe that their numbers for this category are reliable. The State of Florida, commenting on its stormwater control cost estimate of $4.23 billion, says that "Due to the elementary state of the art of this category, this estimate may be off a magnitude of ten or a magnitude of one hundred."

### *Industrial Costs*

Most of the States do not provide an estimate of costs for reducing industrial pollutant discharges to the levels called for in the Act by 1983. Of the 13 States that do estimate total industrial costs (Table III-2) about half base their estimates on the "best practicable" treatment levels required by 1977, while the other half include estimates for "best available" treatment required by 1983. In addition, many excluded thermal discharges and small plants from their analysis. For these reasons, the figures may underestimate industrial expenditures needed to meet the 1983 goals.

To provide a reasonable basis of comparison for industrial costs among States, these costs are presented as a percentage of the estimated municipal treatment costs. In addition to the quantitative estimates, two States comment on the order of magnitude of industrial costs as related to municipal costs. Alabama reports that industrial costs "will greatly exceed the projected municipal costs on the basis of volume alone", while Colorado states that "the industrial costs would be considerably less than the municipal total". Of the 13 quantitative industrial cost estimates, 10 are less than 25 percent of their State's projected municipal costs, while two, Tennessee and Texas, are over 100 percent. There is no ready explanation for this variability. These two high ratio States, plus Alabama, used different estimating methods, and their methods were also used by other States reporting low industrial/municipal cost ratios. None of the three States can be considered highly industrialized.

The State estimates are generally lower than the preliminary compilations for the *Cost of Air and Water Pollution Control (1976-1985)* report in which EPA estimates that industrial investment expenditures to meet the 1983 goals will be approximately one-half of the State-reported municipal needs, excluding stormwater control. The probable reasons that this estimate is higher than the State estimates of industrial costs are exclusion of thermal controls and small plants by some States and use of the 1977 standards

## TABLE III-2

## INDUSTRIAL CONTROL COSTS AS REPORTED BY STATES+

| State | Total industrial cost estimate (millions of dollars) | Municipal costs, excluding stormwater control (millions of dollars) | Industrial/municipal (%) |
|---|---|---|---|
| Delaware** | 100 | 548 | 18 |
| Georgia* | 45 | 1,584 | 3 |
| Illinois* | 800 | 6,440 | 12 |
| Indiana* | 1,136 | 3,004 | 38 |
| Iowa* | 50 | 990 | 5 |
| Kansas** | 156 | 2,086 | 7 |
| Michigan* | 1,200 | 8,900 | 13 |
| New York** | 1,000 | 17,421 | 6 |
| North Carolina** | 353 | 1,531 | 23 |
| Ohio* | 386 | 7,647 | 5 |
| Tennessee** | 1,567 | 1,318 | 119 |
| Texas** | 3,315 | 2,982 | 111 |
| Virginia* | 47 | 2,128 | 2 |

+ These figures were not developed by EPA.

*Best Practicable Control Technology Currently Available (1977 level treatment).

**Best Available Control Technology Economically Achievable (1983 level treatment).

rather than the 1983 standards by about half the States.

### *Nonpoint Source Control*

Very few States estimated costs for control of what they identified as nonpoint sources. Pennsylvania, Kansas, and Illinois estimated costs for controlling mine drainage (Table III-3). These estimates are $1 billion for Pennsylvania, $22 million for Kansas, and $346 million for Illinois (31 percent, 1 percent, and 5 percent respectively of estimated municipal costs).

Seven States (Minnesota, Wisconsin, Tennessee, Iowa, Kansas, Nebraska, and New York) present Statewide estimates of erosion control costs, generally from information provided by the Soil Conservation Service (Table III-3). For the four States to the north and east of the Midwest farm belt these estimates ran from 1 percent of projected municipal needs excluding stormwater control (New York) to 23 percent (Tennessee). In contrast, Iowa, Kansas, and Nebraska report erosion control costs to be of the same order of magnitude as municipal costs. In addition, many western States report that agricultural nonpoint source control costs would probably be much higher than municipal costs, although they mention no specific figures.

Some other States provided costs for pilot programs for control of local, generally small-scale nonpoint sources, but no other efforts to estimate costs statewide are attempted.

### *Benefits*

No States attempt to quantify specifically the benefits to be derived from improving water quality, although several do present figures on local expenditures for recreation, tourism, sport and commercial fishing, and other water related activities. However, the States are not able to assess the incremental increases that would occur in these activities if the 1983 goals were met.

Other economic benefits from clean water mentioned by the States are increased property values, lower pretreatment costs for municipal water supplies and for industry, human health effects, greater agricultural value for animals and for irrigation, and improved navigation. Almost all States discussing potential benefits mention the difficulty of quantifying them.

## TABLE III-3

## NONPOINT SOURCE[+] CONTROL COSTS

| State | Rural Erosion | | Mine wastes | |
|---|---|---|---|---|
| | Costs (millions of dollars) | Percent[*] | Costs (millions of dollars) | Percent[*] |
| Illinois | | | 346 | 5 |
| Iowa | 1,677 | 169 | | |
| Kansas | 1,539 | 74 | 22 | 1 |
| Minnesota | 300 | 22 | | |
| Nebraska | 733 | 79 | | |
| New York | 210 | 1 | | |
| Pennsylvania | | | 1,000 | 18 |
| Tennessee | 309 | 23 | | |
| Wisconsin | 168 | 7 | | |

[+] As identified by the States.
[*] Nonpoint source/municipal (excluding stormwater control).

### *Comparison of Costs and Benefits*

Most States realize that a comprehensive review of the potential costs and benefits of achieving the goals stated in the 1972 Act is necessary, given the expected level of expenditures. However, in addition to the difficulties in quantifying costs and benefits, the States also have problems applying a single set of criteria to all waters.

The overall tendency is to categorize the costs and benefits by different classes of waterbodies. For example, Colorado believes that the benefits of achieving fishable, swimmable waters would outweigh the costs in the mountain resort areas, but not in the agricultural areas where the primary water use is irrigation. Other States point out that some of their waters would never be suitable for fishing or swimming because of natural flow conditions or other natural problems. For these waters a high level of pollution control expenditures could not be justified.

Therefore, while States voice general agreement with the goals of the 1972 Act, most think that cost/benefit analyses of achieving those goals should be applied separately to different types of waterbodies.

# Chapter IV

# Nonpoint and Diffuse Sources

Concern has increased during the past few years over the role of nonpoint source pollution as one of the primary causes of water quality problems. However, the quantification of this problem is not easy, and only a few reports attempted it. Most States only provided general, qualitative descriptions of the problems with little or no discussions of control measures. Again, the term "nonpoint source" is descriptive and does not imply legal categorization.

## Summary

Almost all of the States in their 305(b) submissions indicate that a greater emphasis is needed to determine more accurately the amounts, causes, effects, and control of nonpoint sources. As an example of the importance of these problems, Iowa estimates that for most of its river basins, nonpoint sources contribute over 90 percent of the annual phosphorus and nitrogen loads (Tables IV-1, IV-2). Several States, including Vermont, New Hampshire, and Texas have developed or are developing overall nonpoint source strategies, but most feel that more research is required before effective programs can be implemented.

The different human-related nonpoint sources of pollution are of varying degrees of concern depending on which areas of the country are being studied.

TABLE IV-1

ANNUAL PHOSPHORUS LOAD FOR SELECTED IOWA RIVER BASINS

| River | Total (lbs/year) | Point sources (lbs/year) | Nonpoint sources (lbs/year) | Percent of total from nonpoint sources |
|---|---|---|---|---|
| Floyd | 720,207 | 29,807 | 690,400 | 95.9 |
| Little Sioux | 1,851,632 | 129,088 | 1,722,544 | 93.0 |
| Chariton | 879,916 | 48,203 | 831,713 | 94.5 |
| Des Moines | 5,621,007 | 586,015 | 5,034,992 | 89.6 |
| Iowa | 1,723,975* | 103,445* | 1,620,530* | 94.0 |
| Cedar | 5,099,507 | 1,526,775 | 3,572,732 | 70.1 |

*Orthophosphorus.

TABLE IV-2

ANNUAL NITROGEN LOAD FOR SELECTED IOWA RIVER BASINS

| River | Total (lbs/year) | Point sources (lbs/year) | Nonpoint sources (lbs/year) | Percent of total from nonpoint sources |
|---|---|---|---|---|
| Floyd | 1,705,984 | 65,171 | 1,640,813 | 96.2 |
| Little Sioux | 9,609,556 | 85,308 | 9,522,248 | 99.1 |
| Chariton | 1,585,427 | 24,795 | 1,560,632 | 98.4 |
| Des Moines | 41,334,897 | 695,235 | 40,639,662 | 98.3 |
| Iowa | 2,075,830 | 91,287 | 1,984,543 | 95.6 |
| Cedar | 6,804,881 | 1,552,334 | 5,252,547 | 77.2 |

- Agricultural activities affect streams across the nation but are of primary concern in the southern, central, and western States.
- Erosion from silvicultural activities is a problem in several southern and western States.
- Acid mine drainage and other problems associated with mining activities, such as erosion and contamination from metals were noted by States in the Appalachian and Rocky mountain areas. Several southern and southwestern States described problems associated with oil drilling.
- Urban runoff was referred to as both a point source and a nonpoint source. Because of its diffuse nature, it is discussed in this chapter. While 39 States described this problem, the most severe impacts from urban runoff are in the Northeast and the Great Lakes area.

## Agricultural Nonpoint Sources

Agricultural nonpoint sources of pollution as identified by the States include: Cultivated crop fields, forage crop fields, orchards, vineyards, range land, pasture land, confined animal feedlots, and aquaculture project areas producing algae, shellfish, and finfish.

Activities associated with crop and livestock production resulting in nonpoint source pollution were reported by 43 States (Table IV-3). When forests or grass lands are cultivated, erosion is increased. Crop fertilization provides nutrients, principally phosphates and nitrates, which are transported into lakes and streams, thereby accelerating eutrophication. Extensive irrigation in western areas leaches salts out of the soil, and as a result, the irrigation return flows have contributed to very high stream salinities. Pesticides are also transported into the surface waters. The runoff from range lands in the central and southwestern States, from pasture lands, and from feedlots (for beef, dairy, pork, and poultry) carries loads of suspended solids, nutrients, coliform bacteria, oxygen-demanding materials, and salts.

Control programs vary from State to State, although conservation programs to control erosion have been carried on in all States for a number of years, assisted by the Department of Agriculture. Vermont has sponsored nonpoint source pollution control workshops. In Virginia, the Soil Conservation Service has been alerting farmers to runoff problems and listing alternative controls—for example, controlling livestock access to streams in coastal shellfish areas. Indiana and a number of other States have passed confined feeding control laws. The Interstate Colorado River Basin Salinity Control Forum is investigating irrigation problems in the Colorado basin. In addition, many State agencies and universities are engaged in nonpoint source assessment studies.

## Silvicultural Nonpoint Sources

Silvicultural activities associated with harvesting, log transport, and forest regeneration result in nonpoint source pollution, particularly in southern and western States (Table IV-3). Removing the forest canopy along stream banks and lakes causes water temperatures to rise. Timber harvesting increases surface runoff, which then transports suspended solids, BOD, and dissolved solids to surface waters. Log transporting activities also increase runoff and suspended solids. Fertilizing and pest control processes can load surface waters with nutrients and toxicants.

Several States are working on ways to deal with these problems. In New Hampshire, for example, regulations covering logging operations, if properly enforced, can largely control nonpoint source problems associated with silvicultural activities. Vermont has held nonpoint source workshops dealing with forest practices. In Virginia, financial assistance for stabilization of logging roads is available to forest landowners through Federal programs administered by the Soil Conservation Service, and technical assistance is provided in the field by the Virginia Division of Forestry. A number of other states, such as Oregon and Washington, have passed comprehensive forest practice acts.

## Mining Nonpoint Sources

Mining nonpoint sources include: Active and abandoned subsurface mines, spoil and tailing deposits, washing process areas, primary acid treatment process areas, surface mines, quarries, overburden deposits, oil shale process areas, active and abandoned wells, holding ponds, and secondary and tertiary extraction process areas.

## FIGURE IV-3

## NONPOINT SOURCE PROBLEMS DISCUSSED IN STATE 305(b) REPORTS

| | Nonpoint source problems | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Agricultural | Silvicultural | Mining | Construction | Hydrologic modification | Urban | Residual waste disposal | Salt water intrusion | Proposed energy development |
| Alabama | X | X | X | | | X | | | |
| Alaska* | | | | | | | | | |
| American Samoa | | | | | | | X | | |
| Arizona† | | | | | | | | | |
| Arkansas | X | X | X | | | X | | | |
| California | X | X | X | X | X | X | X | X | |
| Colorado | X | X | X | | | X | X | | X |
| Connecticut | X | | | X | | X | | | |
| Delaware | X | | | | | X | | | |
| District of Columbia | | | | X | | X | | | |
| Florida | X | X | X | | | X | | X | |
| Georgia | X | | | | | X | | | |
| Territory of Guam | X | | | X | | X | X | | |
| Hawaii | X | | | | | X | X | | |
| Idaho | X | X | X | X | | X | | | |
| Illinois | X | | X | | | X | | | |
| Indiana | X | | X | X | X | X | | | |
| Iowa | X | | | | | X | X | | |
| Kansas | X | | X | X | | X | | | |
| Kentucky | X | X | X | | | | | | |
| Louisiana | X | X | X | | | X | | X | |
| Maine | X | X | X | X | | X | | | |
| Maryland | X | X | X | | | X | | | |
| Massachusetts* | | | | | | | | | |
| Michigan† | | | | | | | | | |
| Minnesota | X | | | X | X | X | | | |
| Mississippi* | | | | | | | | | |
| Missouri* | | | | | | | | | |
| Montana | X | X | X | | | | | | |
| Nebraska | X | | | X | | X | | | |
| Nevada | X | X | X | X | | X | X | | |
| New Hampshire | X | X | X | X | X | X | | | |
| New Jersey | X | | | X | | X | X | | |
| New Mexico | X | | | | X | | | | X |
| New York | X | | | X | X | X | | | |
| North Carolina | | | | X | | | | | |
| North Dakota† | | | | | | | | | |
| Ohio | X | X | X | X | | X | | | |
| Oklahoma | X | | X | | | X | | | |
| Oregon† | | | | | | | | | |
| Pennsylvania | X | | X | | | X | | | |
| Commonwealth of Puerto Rico | X | | | | | X | | | |
| Rhode Island | X | | X | X | | X | X | | |
| South Carolina | X | | | | | X | | | |
| South Dakota | X | | | | | X | | | |
| Tennessee | X | | X | X | X | X | | | |
| Texas | X | X | X | | X | X | | | |
| Trust Territories | | | | X | | | | X | |
| Utah | X | X | X | X | | X | | | |
| Vermont | X | X | X | X | | | | | |
| Virginia | X | X | X | X | | X | | | |
| Virgin Islands | | | | X | | | | | |
| Washington | X | X | X | | X | X | | | |
| West Virginia | X | X | X | X | | X | | | |
| Wisconsin | X | | | X | | X | | | |
| Wyoming | X | X | | | | X | | | X |
| Total | 44 | 21 | 27 | 25 | 9 | 40 | 9 | 4 | 3 |

*State report was not received in time for inclusion.
†Not discussed by category

Subsurface mining activities in eastern and western mountain States (Table IV-3) cause runoff to be loaded with suspended solids, acids, salts, and metals. Aquifer water pressures and groundwater flows are disturbed. Pathways may be created between saline and fresh water aquifers, resulting in salt water intrusions. Groundwater may also be loaded with acids and metals.

Surface mining activities increase runoff, reduce aquifer recharge, and load runoff and leachates with acids, salts, and metals.

Runoff from oil wells in several southern and southwestern States are loaded with drilling chemicals, suspended solids, and petroleum products. Leachates from unlined holding ponds carry drilling chemicals and salts into groundwaters. Wells may create pathways between saline and fresh water aquifers, resulting in salt water intrusion.

Some States have enacted legislation to regulate mining activities which cause pollution. One example is Virginia; its Coal Surface Mining Law provides funds for reclamation of coal surface mines and for sediment control. The State of Maryland's Abandoned Mine Drainage Act (1970) allots $5 million to study and improve facilities for dealing with similar problems. The Illinois Environmental Protection Agency has been involved in developing a comprehensive strategy to prevent further water quality degradation from active mines, and has also carried out a statewide assessment of abandoned mines.

## Construction Nonpoint Sources

Construction nonpoint sources described by 25 States include: devegetated slopes, areas with petroleum and other chemical spills, building materials and chemical storage deposits, and fresh concrete and asphalt surfaces.

Runoff is often increased and aquifer recharge is reduced as a result of construction activities. Construction-site runoff may carry loads of suspended solids, nutrients, BOD, pesticides, herbicides, petrochemicals, and construction material wastes. Figures for Rhode Island indicate the magnitude of erosion and sedimentation problems from construction sites (Table IV-4). Although they do not cover very large areas, construction sites contribute a substantial portion of total sediment yields.

Some States have enacted sediment control laws. Michigan passed a Soil Erosion and Sediment Act in 1973, and Virginia enacted its Erosion and Sediment Control Law in 1974.

## Hydrologic Modification Nonpoint Sources

Although dam construction, dredging and other channel activities result in nonpoint source pollution, only nine States mention these problems (Table IV-3). Minnesota has problems associated with dredge spoil material in the upper Mississippi and in the Duluth-Superior

TABLE IV-4

SEDIMENT YIELDS FROM VARIOUS LAND USES IN RHODE ISLAND*

| Land use | Acres | Annual sediment yields (tons) |
|---|---|---|
| Construction sites | 6,393 | 228,363 |
| Pasture | 18,294 | 9,943 |
| Woodland | 387,605 | 129,209 |
| Cropland | | |
| treated now | 17,151 | 34,301 |
| needing treatment | 24,375 | 273,000 |
| Urban land | 114,688 | 164,792 |
| Road banks | 2,447 | 36,009 |
| Streambanks | 10 | 3,995 |
| Open land formerly cropped | 22,952 | 21,555 |
| Orchard, bush fruit, horticulture | 852 | 1,088 |

*Data developed by The Soil Conservation Service, U.S. Department of Agriculture.

Harbor. Indiana has similar problems in the Indiana Harbor Ship Canal, and Texas lists the Sulfur, Trinity, Nueces, and Rio Grande River basins as areas with problems related to dredging.

## Urban Nonpoint Sources

Urban nonpoint sources described by 39 States are the extensive impervious (paved and roofed) surfaces. These areas increase runoff and reduce aquifer recharge.

A study of urban runoff constituents in Wisconsin, which provided much greater detail than did most States, identified the following: oil, street litter, salt and other ice control chemicals, animal droppings, insecticides, dust, industrial wastes, BOD, suspended solids, phosphates, nitrates, and heavy metals. The runoff from the 669,300 urban acres in Wisconsin load receiving waters with 1,338,600 to 5,354,400 pounds per day of BOD and 4,685,100 to 16,063,200 pounds per day of suspended solids. Wisconsin also reports that urban runoff from a typical moderate sized city will load receiving waters with 100.000 to 250,000 pounds per year of lead and 6,000 to 30,000 pounds per year of mercury.

# Chapter V

# National Water Quality Surveillance System

The National Water Quality Surveillance System (NWQSS), a nationwide network of stream monitoring stations, began operating in 1974. NWQSS was established under Section 104(a) (5) of the 1972 Act for the purpose of "monitoring the quality of the navigable waters and ground waters and the contiguous zone and the oceans . . ." Initial efforts are concentrated at 188 stations in 104 areas representative of land uses within the continental United States. For this report, data were analyzed for 108 stations in 56 areas. The station locations and the complete data for each downstream station are presented in Appendix A.

## Summary

A comparison of the NWQSS data with EPA's proposed water quality criteria levels shows that most parameters fall within these criteria levels most of the time. (At the time this report was prepared, the proposed criteria levels had not been formally published. Therefore, the final criteria may differ from those used for this analysis.) However, some parameters, in particular iron, manganese, and fecal coliform bacteria, consistently exceed their criteria. (It should be noted that the total heavy metal measurements which were used include some metal which occurs in suspended form and is not as damaging to aquatic life or human health as is dissolved metal. The main reasons the criteria were developed for total metal rather than dissolved metal concentrations is that some of the suspended material may dissolve under certain conditions.) The percentage of observations where criteria were exceeded (criteria exceptions) was 53 percent for iron, 84 percent for manganese, and 67 percent for fecal coliform bacteria. Mercury levels were also measured at most stations, and, although the laboratory techniques used are not accurate enough to measure mercury at the criteria levels, there were strong indications of significant mercury concentrations. The data also show that:

- Higher levels of both municipal/industrial activity and agricultural activity are correlated with increased levels of nutrients and fecal coliform bacteria. These pollutant levels are more strongly related to municipal/industrial activity than to agricultural activity.
- Oxygen-demanding loads, dissolved oxygen, and turbidity were not as strongly correlated with land use activity.

## Description of System

The basic monitoring procedure was to establish pairs of stations upstream and downstream from particular drainage areas of interest. The drainage areas were selected to represent a cross section of different levels of land use. The station locations were selected jointly by the States, EPA Regional Offices, and EPA Headquarters. Most of the monitoring is being done through a contract with the U.S. Geological Survey.

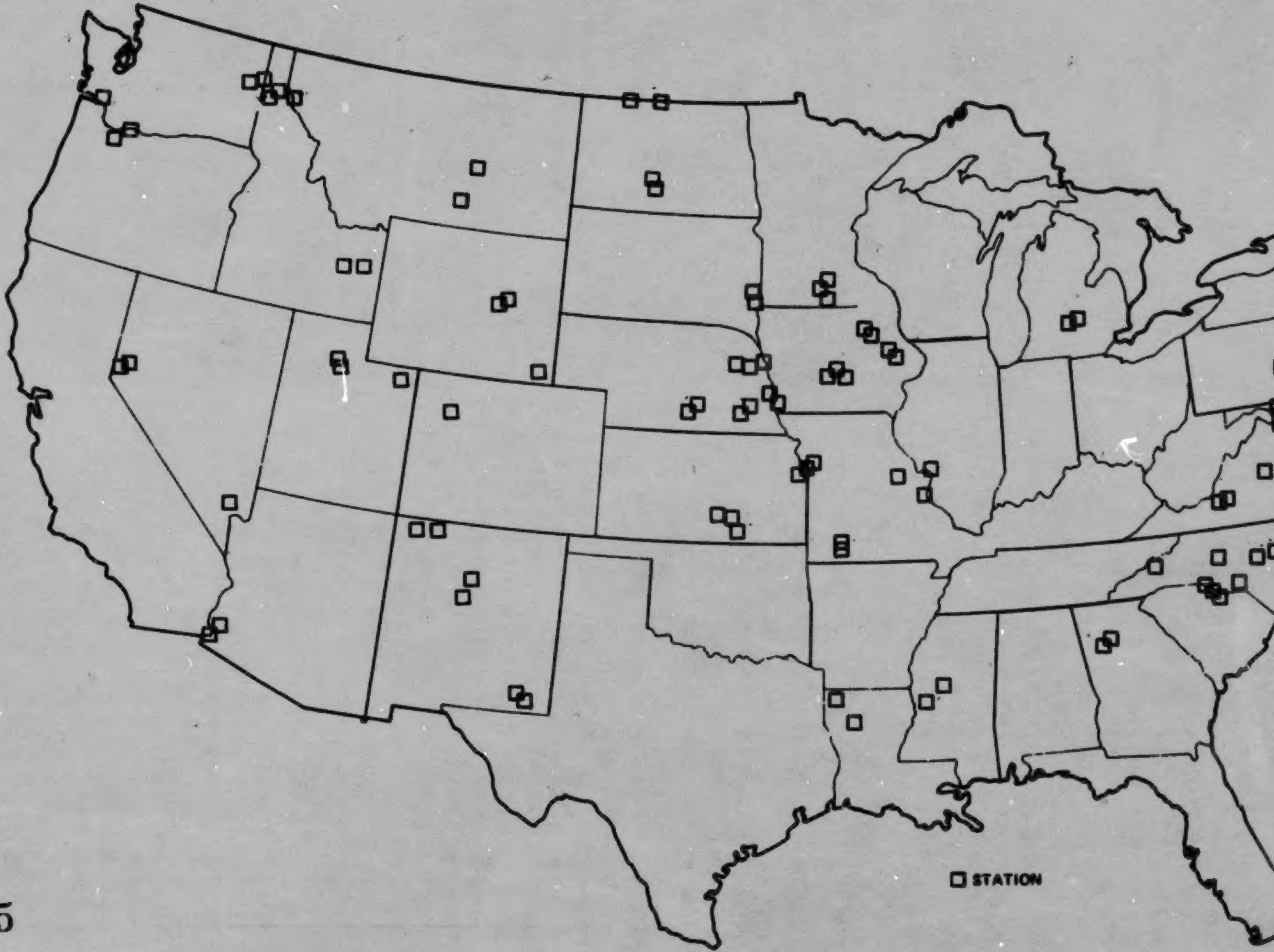
The primary analytical emphasis for this year is to investigate possible relationships between land use characteristics and water quality measurements. The purpose of this analysis is to provide a basis for assessing the effects of water pollution control programs in different types of areas.

The first year in operation has provided a data base consisting of over 30 water quality parameters measured every two weeks in 56 areas representative of the major land use characteristics across the country (Figure V-1). This data base will be the starting point against which future measurements can be compared in order to determine national trends in water quality. The land use characteristics of these areas have been quantitatively defined with respect to population density, manufacturing activity, and agricultural activity.

## Limitations of Data

Before presenting the results, it is necessary to point out the limitations of the data base being used. The small number of areas being con-

## FIGURE V-1
## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM STATION LOCATIONS



sidered increases the possibility that the system may be biased toward certain characteristics which could affect water quality. The effects of stream size and geographical location were investigated, and it was found that taking these effects into consideration had no significant impact on the results.

Because of greater interest in more populated areas, the NWQSS sample has a majority of stations in areas of higher land use activity than the national average. Therefore, the results probably overstate the absolute levels of pollutants found across the country. The results are also biased towards areas located on larger streams, since 66 percent of the streams in the NWQSS sample have flows greater than 1,000 cubic feet per second (cfs), while only 10 percent of the stream miles in the United States have flows greater than 1,000 cfs. This bias may also affect the validity of using absolute levels to describe national water quality conditions. However, the data do provide clear indications of which parameters are presenting significant problems and how land use activities affect pollutant levels.

## Magnitude of Problems for Different Parameters

For the 16 NWQSS parameters for which water quality criteria are being set by EPA, eight apparently have widespread problems, both from the percentage of criteria exceptions and from the number of stations with at least one criteria exception. Four of them (total lead, total zinc, ammonia, and nitrites plus nitrates) have criteria exception rates of between 10 percent and 50 percent, while another three (total iron, total manganese, and fecal coliform bacteria) have criteria exception rates of over 50 percent (Table V-1).

The percentage of criteria exceptions for mercury was difficult to determine because the laboratory techniques used to measure mercury concentrations are only accurate to 0.1 or 0.2 micrograms per liter (ug/l), whereas the criteria level is 0.05 ug/l. Approximately one-half the readings indicate that some mercury is present, but that the concentration is below the 0.1 or 0.2 ug/l measurement accuracy limit. Therefore, for these readings it is not known if the criteria level was exceeded. Of the remaining readings, 22 percent were reported to be zero and 78 percent were reported to be above the criteria level.

Five parameters (total arsenic, total cadmium, total chromium, dissolved oxygen, suspended solids) showed relatively few problems (Table V-1). That is, they exceed their criteria 5 percent of the time or less. (The reason most States found dissolved oxygen levels to be a significant problem (Chapter 1) is that their standards are generally higher than the 4 milligrams per liter (mg/l) criteria used for this analysis.) The other three criteria parameters (pH chlorides, sulfates) have exception rates higher than 5 percent, but most of the exceptions are in only one or two specific areas (Table V-1). Thus, these parameters also do not indicate widespread problems.

## Variations in Water Quality with Land Use

The percentage of criteria exceptions for un-ionized ammonia, nitrites plus nitrates, and fecal coliform bacteria is consistently higher in areas affected by high municipal/industrial activity than in areas of low municipal/industrial activity (Table V-2). The criteria exception rates in percent are as follows:

| | Municipal/Industrial Activity | |
|---|---|---|
| | High | Low |
| Ammonia | 15 | 8 |
| Nitrites + nitrates | 30 | 17 |
| Fecal coliform bacteria | 79 | 52 |

The differences are all statistically significant at the .05 level, meaning that the probability of these differences occurring due to chance is less than 5 percent.

On the other hand, only nitrites plus nitrates and fecal coliform bacteria show significantly higher percentages of exceptions below high agriculture areas than below low agriculture areas (Table V-2). The relationship between agricultural activity and criteria exceptions for nitrites plus nitrates is more pronounced (35 percent for high vs. 11 percent for low agricultural activity) than is the relationship between municipal/industrial activity and nitrites plus nitrates. However, fecal coliform bacteria exceptions appear to be less dependent on agricultural activity (72 percent for high vs. 61 percent

## TABLE V-1

## SUMMARY OF CRITERIA EXCEPTIONS OF SELECTED NWQSS PARAMETERS

| Parameter | Basis for criteria | Criteria level | Number of observations/percentage of exceptions | Number of stations/percentage with at least one exception |
|---|---|---|---|---|
| Physical modification | | | | |
| Suspended solids | AL* | 400 mg/1+ | 791/5 | 44/39 |
| Harmful substances (metals) | | | | |
| Arsenic | WS‡ | 50 ug/1 | 397/1 | 33/3 |
| Cadmium | AL | 4 ug/1‡ | 454/1 | 36/11 |
| Chromium | AL | 300 ug/1 | 463/1 | 39/3 |
| Iron | AL | 1000 ug/1 | 744/53 | 50/86 |
| Lead | WS | 50 ug/1 | 471/16 | 35/51 |
| Manganese | WS | 50 ug/1 | 424/84 | 37/92 |
| Zinc | AL | 70 ug/1 | 577/44 | 46/87 |
| Salinity, acidity, alkalinity | | | | |
| pH | AL | 6.5–9.0 | 1,168/8** | 56/30 |
| Chlorides | WS | 250 mg/1 | 680/6†† | 53/9 |
| Sulfates | WS | 250 mg/1 | 645/18‡‡ | 53/15 |
| Eutrophication potential | | | | |
| Ammonia | AL | 0.025 mg/1 | 844/11 | 52/40 |
| Nitrites and nitrates | AL | 1.1 mg/1 | 897/24 | 52/48 |
| Health hazards | | | | |
| Fecal coliform bacteria | RE‡‡ | 100/200 m1 | 907/67 | 47/89 |
| Oxygen depletion | | | | |
| Dissolved oxygen | AL | 4 mg/1 | 1,120/4 | 52/21 |

*Aquatic life support—1975 proposed EPA criteria.

‡Water supply—1975 proposed EPA criteria.

‡‡Recreation—1975 proposed EPA criteria.

+Supports poor fisheries.

‡30 ug/1 in hard water areas.

**4% for all stations outside North Carolina.

††3% for all stations except Salt Creek, Nebraska.

‡‡5% for all stations except Colorado River at Mexican border. (Over 50 observations, all exceeding criteria, were made at this station.)

## TABLE V-2

## CRITERIA VIOLATIONS WITH LAND USE
(Percentage of Observations Exceeding Criteria)

| | Un-ionized ammonia | Nitrites plus nitrates | Fecal coliform bacteria |
|---|---|---|---|
| High population density (>200/sq. mi.) | 14 | 30 | 78 |
| Low population density (<200/sq. mi.) | 8 | 17 | 57 |
| High manufacturing activity (>$150,000/sq. mi.) | 15 | 30 | 79 |
| Low manufacturing activity (<$150,000/sq. mi.) | 8 | 17 | 52 |
| High agricultural activity (>$15,000/sq. mi.) | 13 | 35 | 72 |
| Low agricultural activity (<$15,000/sq. mi.) | 9 | 11 | 61 |
| Total | 11 | 24 | 67 |

for low agricultural activity) than on municipal/industrial activity.

The results for ammonia, nitrites plus nitrates, and fecal coliform bacteria are supported by observing downstream median concentrations as a function of land use (Table V-3). In addition, total phosphorus, chemical oxygen demand, and total organic carbon levels were also found to be related to both municipal/industrial and agricultural activity.

Similar conclusions are reached using a statistical rank order correlation procedure. The stations are ranked according to both their land use values and their water quality parameter measurements, and those rankings are compared. Significant correlations (at the .05 level) are found for fecal coliform bacteria, total phosphorus, nitrites plus nitrates, total Kjeldahl nitrogen, ammonia, and COD with both population density and manufacturing activity. Fecal coliform bacteria and total phosphorus are also correlated with agricultural activity.

Finally, the 32 areas for which both upstream and downstream data are available were analyzed by taking the difference in the upstream and downstream median values of selected parameters for each area. The median of those differences was notably higher in areas of high

### TABLE V-3

### MEDIANS OF DOWNSTREAM MEDIAN VALUES

| Parameter | High manufacturing activity ( >$150,000/sq.mi.) | Low manufacturing activity ( <$150,000/sq.mi.) | High agricultural activity ( >$15,000/sq.mi.) | Low agricultural activity (<$15,000/sq.mi.) |
|---|---|---|---|---|
| Turbidity (JTU) | 15 | 15 | 15 | 15 |
| Iron (μg/1) | 2,400 | 620 | 1,600 | 800 |
| Conductivity (μMHOs) | 260 | 410 | 260 | 340 |
| Ammonia (mg/1) | .22 | .12 | .15 | .16 |
| TKN (mg/1) | .90 | .64 | .83 | .70 |
| $NO_2 + NO_3$ (mg/1) | .67 | .16 | .55 | .29 |
| Total phosphorus (mg/1) | .31 | .17 | .26 | .14 |
| Dissolved oxygen (mg/1) | 9.0 | 9.3 | 8.9 | 9.3 |
| COD (mg/1) | 24 | 15 | 24 | 15 |
| TOC (mg/1) | 10 | 5.8 | 10 | 6.1 |
| Fecal coliform bacteria (per 100 ml) | 1,200 | 450 | 700 | 500 |

### TABLE V-4

### MEDIANS OF DOWNSTREAM MINUS UPSTREAM MEDIAN VALUES

| Parameter | High manufacturing activity ( >$150,000/sq.mi.) | Low manufacturing activity (<$150,000/sq.mi.) | Urban | Rural |
|---|---|---|---|---|
| Turbidity (JTU) | 1 | 5 | 1 | 7 |
| Conductivity (μMHOs) | 30 | 31 | 30 | 0 |
| Ammonia (mg/1) | 0.18 | 0.04 | 0.17 | 0.02 |
| TKN (mg/1) | 0.33 | 0.13 | 0.28 | 0.03 |
| $NO_2 + NO_3$ (mg/1) | −0.01 | 0.03 | 0.03 | 0.03 |
| Total phosphorus (mg/1) | 0.15 | 0.07 | 0.10 | 0.01 |
| Dissolved oxygen (mg/1) | −0.2 | 0.1 | −0.5 | 0.3 |
| COD (mg/1) | 1 | 2 | 2 | 0 |
| TOC (mg/1) | 0 | 0.9 | .0.3 | 0.5 |
| Fecal coliform bacteria (per 100 ml) | 370 | 236 | 370 | 4 |

municipal/industrial activity for fecal coliform bacteria, total Kjeldahl nitrogen, ammonia, and total phosphorus; while areas of low municipal/industrial activity showed greater increases in turbidity, probably because of greater erosion from the unpaved land areas (Table V-4). The same results are found when these areas are characterized as urban or rural depending on whether or not a town is located in the area (Table V-4). This categorization also shows that dissolved oxygen levels decrease more through urban areas than through rural areas.

The results from the different methods of analyzing water quality variations with land use indicate some definite conclusions. The nutrient parameters (phosphorus and nitrogen) increase with both municipal/industrial activity and agricultural activity, although the increases with municipal/industrial activity are more consistent across all of the parameters and analysis methods. Bacteria levels also show a strong relationship to municipal/industrial activity and a less strong one to agricultural activity.

# Chapter VI

# National Eutrophication Survey

Early in 1972 EPA initiated the National Eutrophication Survey (NES) to identify and study lakes and reservoirs impacted by nutrients from municipal sewage discharges. After the Federal Water Pollution Control Act Amendments of 1972 were passed, the survey was broadened to include lakes impacted primarily by nonpoint sources, and to assist in developing water quality criteria. Overall, however, the sample of lakes is biased toward those impacted by municipal wastes. Therefore, the conclusions concerning limiting nutrients and lake restoration potential are not necessarily representative of conditions in all of the Nation's lakes and reservoirs.

## Summary

The survey found that, for the lakes studied, phosphorus is the element which usually needs to be controlled to slow the rate of eutrophication. Phosphorus is the nutrient directly limiting algal production in 67 percent of those lakes. Although nitrogen is the limiting nutrient in 30 percent of the surveyed lakes, this condition frequently is the result of excessive phosphorus inputs from municipal sewage treatment plants.

Of the 298 lakes surveyed in 22 States east of the Mississippi River, 218 or 73 percent have average total phosphorus concentrations greater than 0.025 milligrams per liter (mg/l) and would therefore, according to an EPA study, be expected to exhibit symptoms of eutrophy (Table VI-1). Of those 218 lakes, 186 or 85 percent were impacted by municipal sewage treatment plants.

Similar relationships were found between total phosphorus loadings and lake trophic conditions. Of the lakes impacted by municipal effluents, 82 percent are being loaded with phosphorus at rates potentially high enough to cause eutrophication problems. For those lakes not receiving identifiable point source contributions, only 30 percent are loaded at a eutrophic rate.

Eutrophication problems in many of the surveyed lakes could be remedied or reduced by control of phosphorus input from municipal wastes and other point sources. For example, 17 percent of the lakes currently receiving municipal effluents and being loaded at a eutrophic rate would have their loading rates reduced to mesotrophic (moderate algal growth potential) or oligotrophic (negligible algal growth potential) following an 80-percent removal of phosphorus from identifiable point source discharges. This is in addition to the reduction in number and intensity of nuisance algal blooms which would be expected at other lakes being loaded at eutrophic rates.

Land use is one of several drainage area characteristics influencing nutrient levels in surface waters. Geological and climatic characteristics are also important. Strictly in terms of land use, however, streams draining agricultural areas have a mean total phosphorus concentration nearly 10 times greater, and a mean total phosphorous export nearly four times greater, than streams draining forested areas. Total nitrogen concentrations in agricultural areas are approximately five times higher than in forested areas, while nitrogen export is more than twice as high. Therefore, lakes and reservoirs located in predominantly agricultural areas might be expected to become eutrophic without the benefit of any control of nutrient runoff. Investigation of the significance of drainage area characteristics other than land use is continuing as part of the survey efforts.

## Limitations of Survey Data

The lakes and reservoirs included in the NES are biased towards those waters impacted by municipal sewage effluents. For that reason, the results should not be interpreted as representative of conditions in all United States lakes and reservoirs. Usually only municipal sewage treatment plants within 25 miles of each water body are specifically identified as contributing to the total nutrient loads of that water body. The nutrient inputs of municipal plants outside that 25-mile limit are included in the total nutrient load to the lake but are not identified by origin.

## TABLE VI-1

## SELECTED NATIONAL EUTROPHICATION SURVEY LAKES
## WITH
## MEDIAN PHOSPHORUS CONCENTRATIONS GREATER THAN 0.025 mg/l

| State | No. of lakes with P loading estimated | No. of lakes exceeding 0.025 mg/1 | No. of lakes exceeding 0.025 mg/1 and impacted by sewage treatment plants |
|---|---|---|---|
| Connecticut | 8 | 8 | 7 |
| Delaware | 6 | 6 | 4 |
| Georgia | 15 | 7 | 7 |
| Illinois | 22 | 21 | 17 |
| Indiana | 21 | 13 | 7 |
| Maine | 9 | 2 | 2 |
| Maryland | 4 | 1 | 1 |
| Massachusetts | 5 | 5 | 5 |
| Michigan | 32 | 25 | 23 |
| Minnesota | 33 | 33 | 30 |
| Mississippi | 5 | 5 | 5 |
| New Hampshire | 4 | 2 | 2 |
| New York | 24 | 12 | 10 |
| North Carolina | 16 | 9 | 7 |
| Ohio | 18 | 18 | 16 |
| Pennsylvania | 16 | 6 | 5 |
| Rhode Island | 2 | 2 | 1 |
| South Carolina | 12 | 8 | 6 |
| Vermont | 6 | 0 | 0 |
| Virginia | 8 | 6 | 6 |
| West Virginia | 4 | 1 | 1 |
| Wisconsin | 28 | 28 | 24 |
| Total | 298 | 218 | 186 |

Therefore, the percentage of the total nutrient load attributed to municipal sewage treatment plants is underestimated for those lakes receiving significant input from beyond the 25-mile limit. Conversely, the nonpoint source nutrient load is overestimated.

Nutrient inputs from industrial sources generally are included in total loadings to each lake, but not identified by origin. Consequently, where industrial sources do supply significant nutrient loads, nonpoint source contributions are overestimated.

## Limiting Nutrient

The limiting nutrient concept, as applied in the algal assay procedure, is based on Liebig's *Law of the Minimum* which states that: "Growth is limited by the substance that is present in minimal quantity in respect to the needs of the organisms." In surface waters unimpacted by human activities, phosphorus is normally the nutrient which limits algal production.

However, even when nitrogen is the limiting nutrient, reducing the eutrophication problem still usually depends on controlling phosphorus inputs. This is because the nitrogen limitation is often the result of excessive phosphorus inputs from point sources, primarily municipal sewage treatment plants, but occasionally industrial dischargers as well. The overall effects are both a change in the limiting nutrient and an increase in the algal population. Effluents from municipal sewage treatment plants without phosphorus removal are particularly detrimental because they contain, on the average, nitrogen and phosphorus in a ratio of about 2.5 parts nitrogen (N) to 1 part phosphorus (P) by weight, whereas algae usually require nitrogen and phosphorus in the ratio of 14N to 1P. Surface waters unimpacted by point sources normally have a ratio in excess of 15N to 1P, even in areas where agricultural land use predominates. Therefore, municipal sewage effluents, as well as industries with phosphorus discharges, might change the natural limiting-nutrient condition, as well as increase the overall level of algal productivity. On the other hand, nutrient inputs from agricultural lands, as an example, could be expected to increase the level of algal production without necessarily shifting the limiting nutrient from phosphorus to nitrogen.

The algal assay, as used to determine the limiting nutrient in each sampled lake, reflects conditions existing in each lake, including the effects of both point and nonpoint waste sources. The algal assay results which have been done for the 623 water bodies surveyed in the 37 States east of the Rocky Mountains demonstrate that, even with human impact, most lakes and reservoirs are still phosphorus limited (Table VI-2).

If municipal and industrial point source contributions to the nitrogen-limited water bodies were eliminated, many of these lakes would revert to the phosphorus limited condition.

## Lake Condition and Restorative Potential

The field sampling of 812 lakes and reservoirs in the United States is now more than 80 percent completed (Figure VI-1). These lakes were not all sampled in the same year; therefore, the data are in various stages of analysis, and the information presented here represents only a portion of what will be available by the end of the Survey in late 1976.

Two criteria are used to determine whether a lake or reservoir is subject to the problems associated with nutrient enrichment. A lake or reservoir is expected to have a potential problem if:

- The median total phosphorus concentration in the water body exceeds 0.025 mg/l, or

TABLE VI-2

ALGAL ASSAY RESULTS

FROM

SELECTED NATIONAL EUTROPHICATION

SURVEY LAKES

| Limiting nutrient | Number of lakes | % of lakes |
|---|---|---|
| Phosphorus | 417 | 67 |
| Nitrogen | 186 | 30 |
| Other | 20 | 3 |
| Total | 623 | 100% |

- The total annual phosphorus load input to the water body exceeds the loading rates proposed by Vollenweider, whose model was used to relate phosphorus loadings to trophic conditions.

Because both criteria have limitations and exceptions, they are intended only as guidelines to determine which lakes might have or develop eutrophication problems.

Of the 298 lakes for which phosphorus concentrations have been determined, 218 (73 percent) exceed the total phosphorus criterion of 0.025 mg/l (Table VI-1); and 186 (85 percent) of these are impacted by municipal sewage plant effluents. This does not imply that in every case municipal effluents alone are responsible for the trophic condition of the lake, because industrial or nonpoint source nutrient contributions also may be significant. In some cases municipal sewage plant effluents contribute a major part of the phosphorus load, but in other cases contributd a relatively minor portion. Of the 234 lakes for which the loading analysis has been completed, 135 (58 percent) receive more than 20 percent of their annual total phosphorus load from municipal sewage treatment plant effluents (Figure VI-2). Assuming 50 percent reduction of the point source phosphorus load, 82 (35 percent) of the lakes would still receive more than 20 percent of their annual total phosphorus load from municipal sources (Figure VI-3). Assuming 80 percent reduction of point source phosphorus, only 9 percent of the lakes would still receive more than 20 percent of their annual total phosphorus load from point sources (Figure VI-4).

FIGURE VI-1

DISTRIBUTION OF LAKES AND RESERVOIRS SAMPLED BY NATIONAL EUTROPHICATION SURVEY

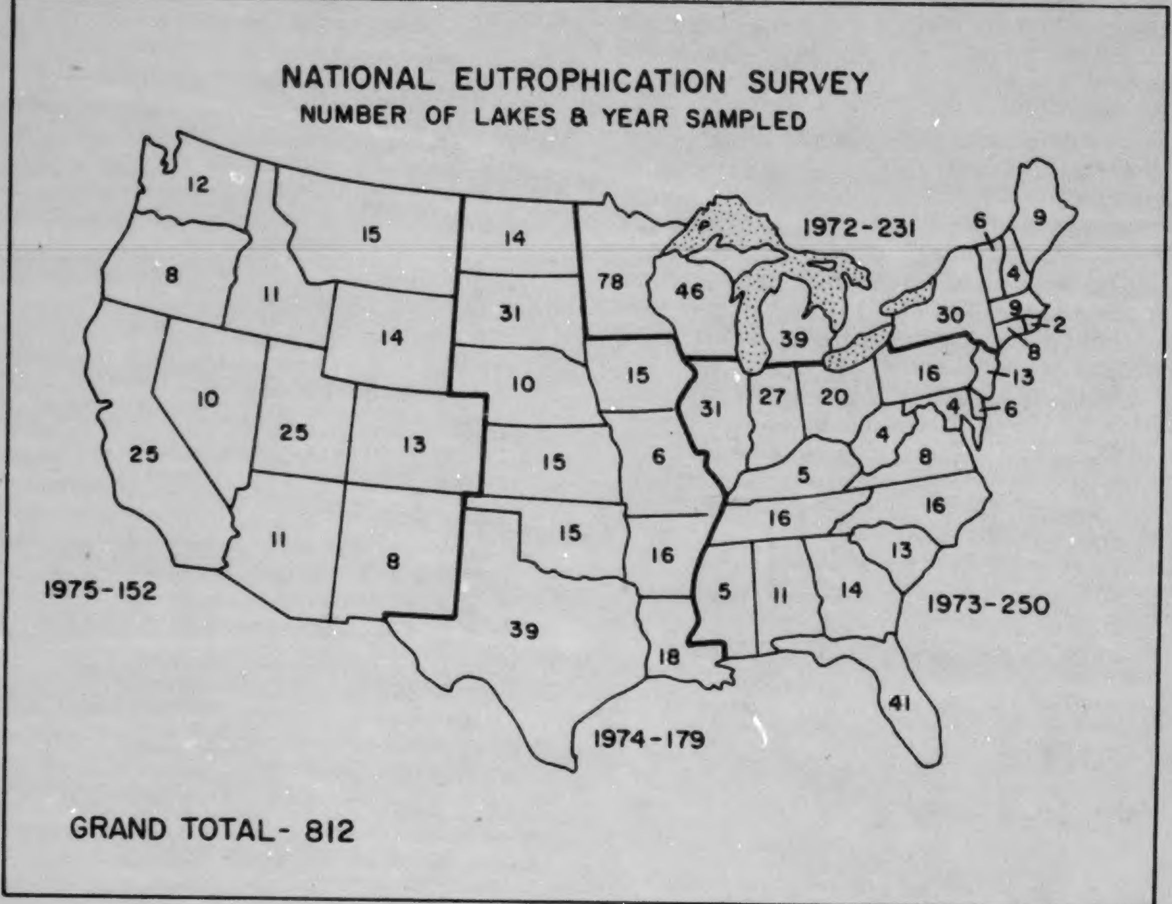

NATIONAL EUTROPHICATION SURVEY
NUMBER OF LAKES & YEAR SAMPLED
12
15
14
78
46
1972-231
6
9
8
11
31
4
39
30
9
2
8
14
10
15
16
13
27
20
31
4
6
10
25
13
15
6
4
8
25
5
16
16
15
11
8
16
13
1975-152
5
11
14
1973-250
39
18
41
1974-179
GRAND TOTAL- 812

FIGURE VI-2

FREQUENCY DISTRIBUTION OF PERCENT OF ANNUAL TOTAL PHOSPHORUS LOAD RECEIVED BY 234 LAKES IN 22 EASTERN STATES FROM MUNICIPAL POINT SOURCES WITH NO PHOSPHORUS REMOVAL

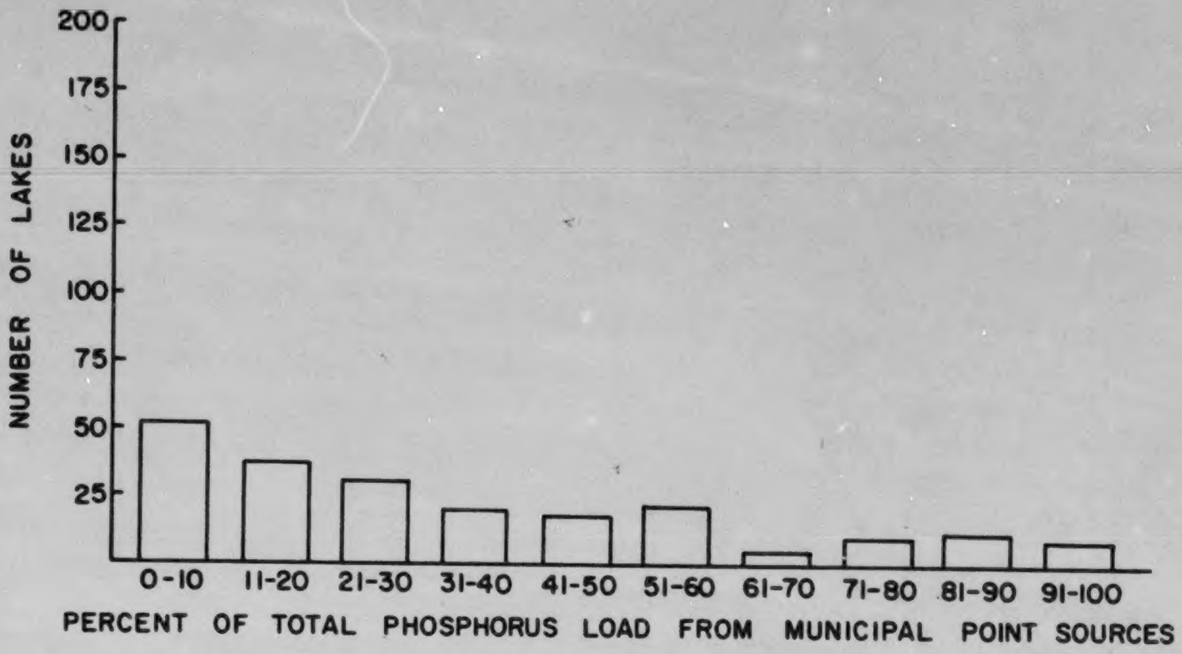


FIGURE VI-3

FREQUENCY DISTRIBUTION OF PERCENT OF ANNUAL TOTAL PHOSPHORUS LOAD RECEIVED BY 234 LAKES IN 22 EASTERN STATES FROM MUNICIPAL POINT SOURCES WITH 50 PERCENT PHOSPHORUS REMOVAL

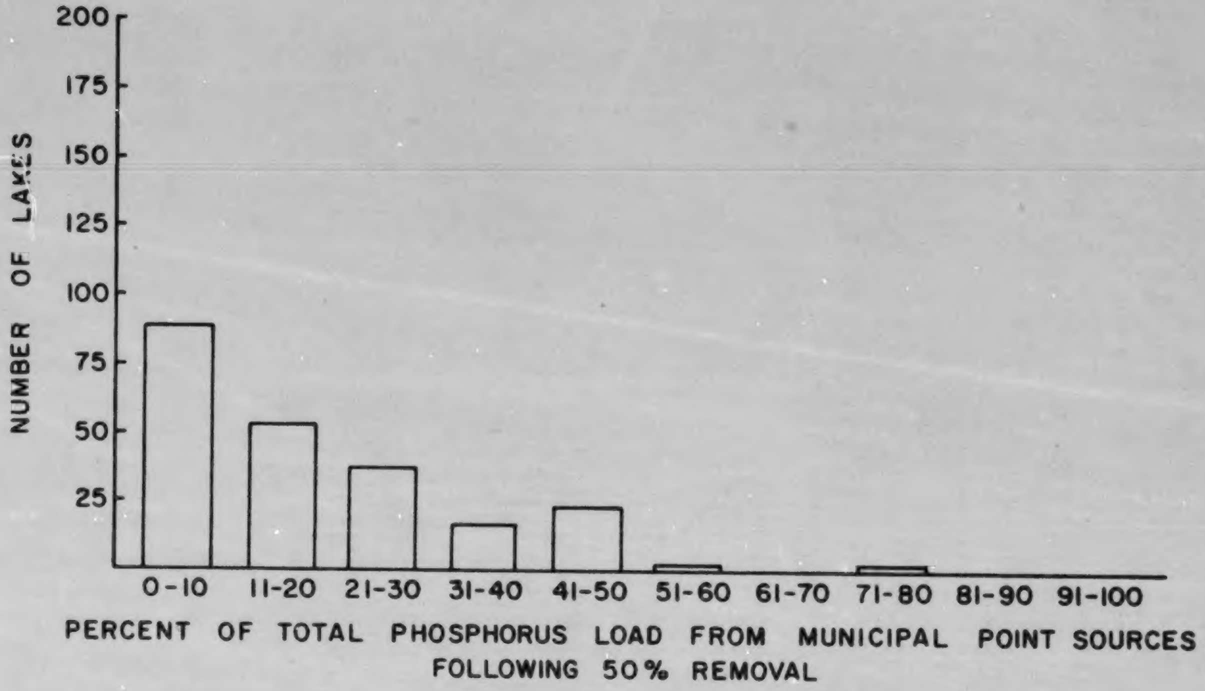
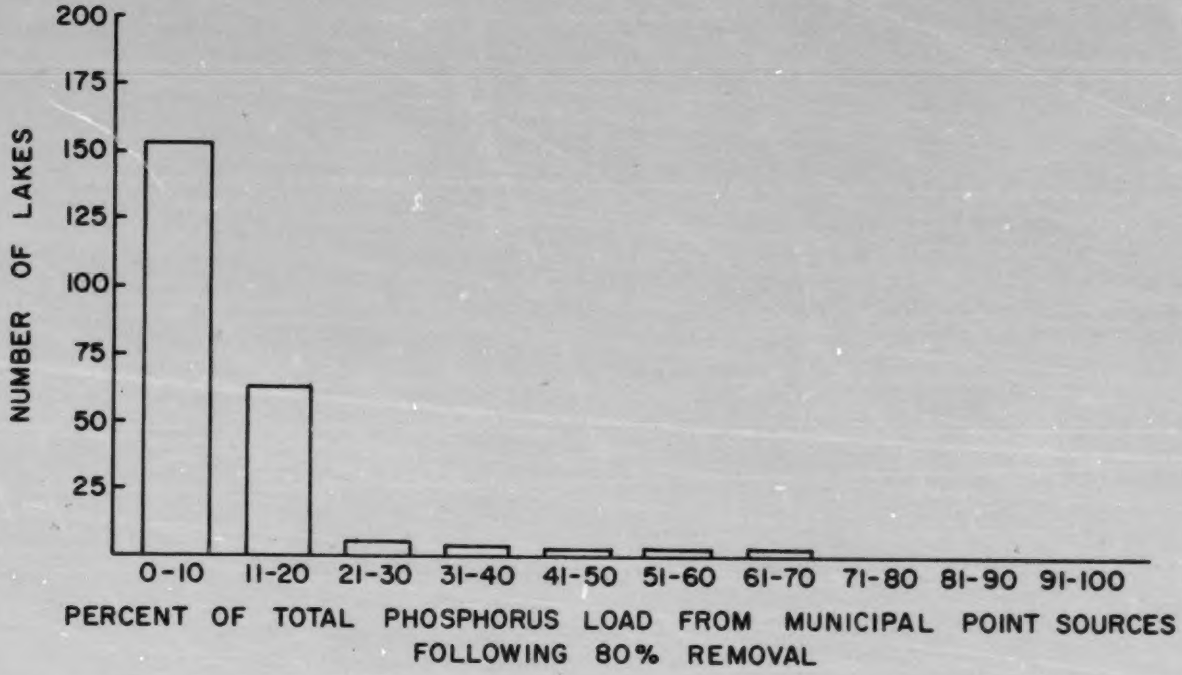


FIGURE VI-4

FREQUENCY DISTRIBUTION OF PERCENT OF ANNUAL TOTAL PHOSPHORUS LOAD RECEIVED BY 234 LAKES IN 22 EASTERN STATES FROM MUNICIPAL POINT SOURCES WITH 80 PERCENT PHOSPHORUS REMOVAL



The results of these load reductions would be a noticeable change in the condition of a significant number of lakes. Of the 133 lakes receiving sewage effluents, 109 (82 percent) receive total annual phosphorus loadings at rates characterized as eutrophic (Figure VI-5, and Appendix B, Table B-2). If 80 percent of the phosphorus were removed at the point sources, the loadings to 18 of the lakes would be reduced to either a mesotrophic or oligotrophic rate. Seven lakes with mesotrophic loading rates now would have oligotrophic rates following 80 percent phosphorus removal. That removal rate would also substantially reduce the number and intensity of nuisance algal blooms in many eutrophic lakes. The nitrogen-limited lakes are generally eutrophic because the nitrogen limitation frequently is caused by excessive phosphorus loads from point sources, particularly municipal sewage treatment plants.

In contrast, trophic conditions are apparently better in 23 lakes impacted only by nonpoint sources, including septic tanks (Figure VI-6, and Appendix B, Table B-3). Only 7 (30 percent) of these lakes received phosphorus loadings at rates characterized as eutrophic. However, four others have symptoms of eutrophy even though the total phosphorus loadings are below the eutrophic rate proposed by Vollenweider. The incidence of nitrogen limitation is also lower in lakes impacted only by nonpoint sources than in those impacted by municipal sewage—17 percent compared to 36 percent.

In summary, both point and nonpoint sources contribute to the total phosphorus load and resulting trophic condition of a lake. However, the data presented here suggest a significant correlation between eutrophic conditions and impacts by municipal sewage treatment plant effluents. If the phosphorus contributions from municipal sewage and other point sources could be substantially reduced, a significant improvement would be anticipated in many of our lakes and reservoirs.

## Impact of Land Use on Nutrient Levels

Land use, geology, soils, climate, and other geographic factors are important in determining nutrient levels in rivers and lakes. The NES presented a unique opportunity to study these relationships on a nationwide scale. Nearly all the approximately 1,000 drainage areas selected for the land use study are included in the approximately 4,200 sampled drainage areas tributary to the Survey lakes.

### *Results for Eastern States*

The relationships between land use and average stream nutrient concentrations have been determined for the 473 drainage areas studied in the eastern United States (Figure VI-7). The mean annual nitrogen and phosphorus concentrations have been determined for six land use categories:

1. Forest; other types negligible—areas comprising greater than 75 percent forest (including forested wetland), less than 7 percent agricultural use, and less than 2 percent urban.

2. Mostly forest; other types present—areas comprising greater than 50 percent forest but not meeting the criteria for the forest category.

3. Mostly agriculture; other types present—areas comprising greater than 50 percent agricultural use, but not meeting the criteria for the agriculture category.

4. Agriculture; other types negligible—areas comprising greater than 75 percent agricultural use, and less than 7 percent urban.

5. Urban; areas comprising greater than 39 percent urban.

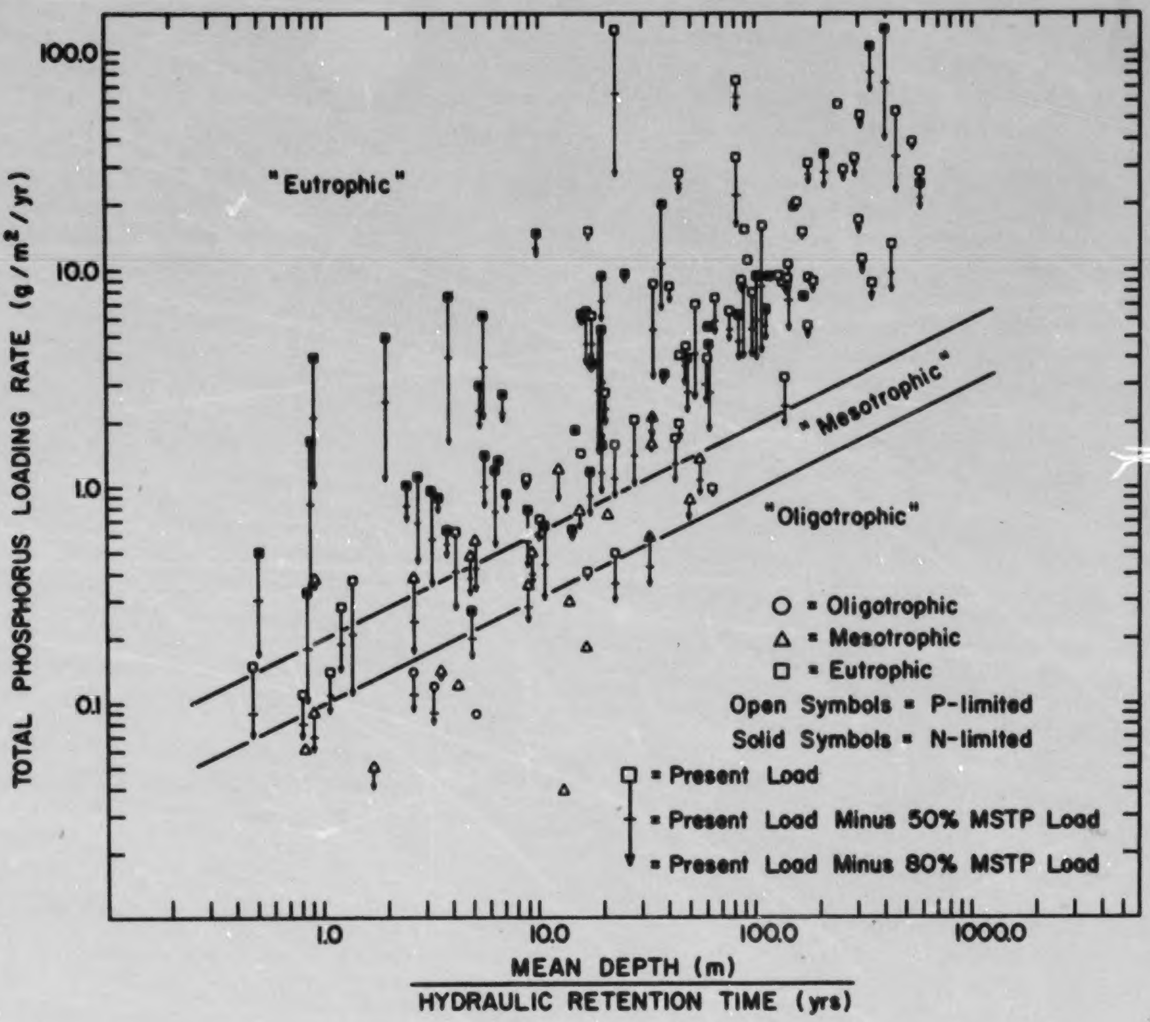
6. Mixed.

Streams draining areas classified as agricultural have total phosphorus concentrations of 0.135 mg/l compared to 0.014 mg/l for streams draining forested areas—almost a ten-fold difference (Figure VI-8). The differences in total nitrogen concentrations between the two land use categories are not as marked—4.170 mg/l in streams draining agricultural lands, or 4.9 times higher than the average of 0.850 mg/l for streams in forested areas.

The export of phosphorus and nitrogen generally follows the same pattern as for stream concentrations—that is, forested areas export the least amount of nutrients, and agricultural areas the greatest. (Figure VI-9). However, the nutrient exports from forested and agricultural areas do not differ as much as nutrient concen-

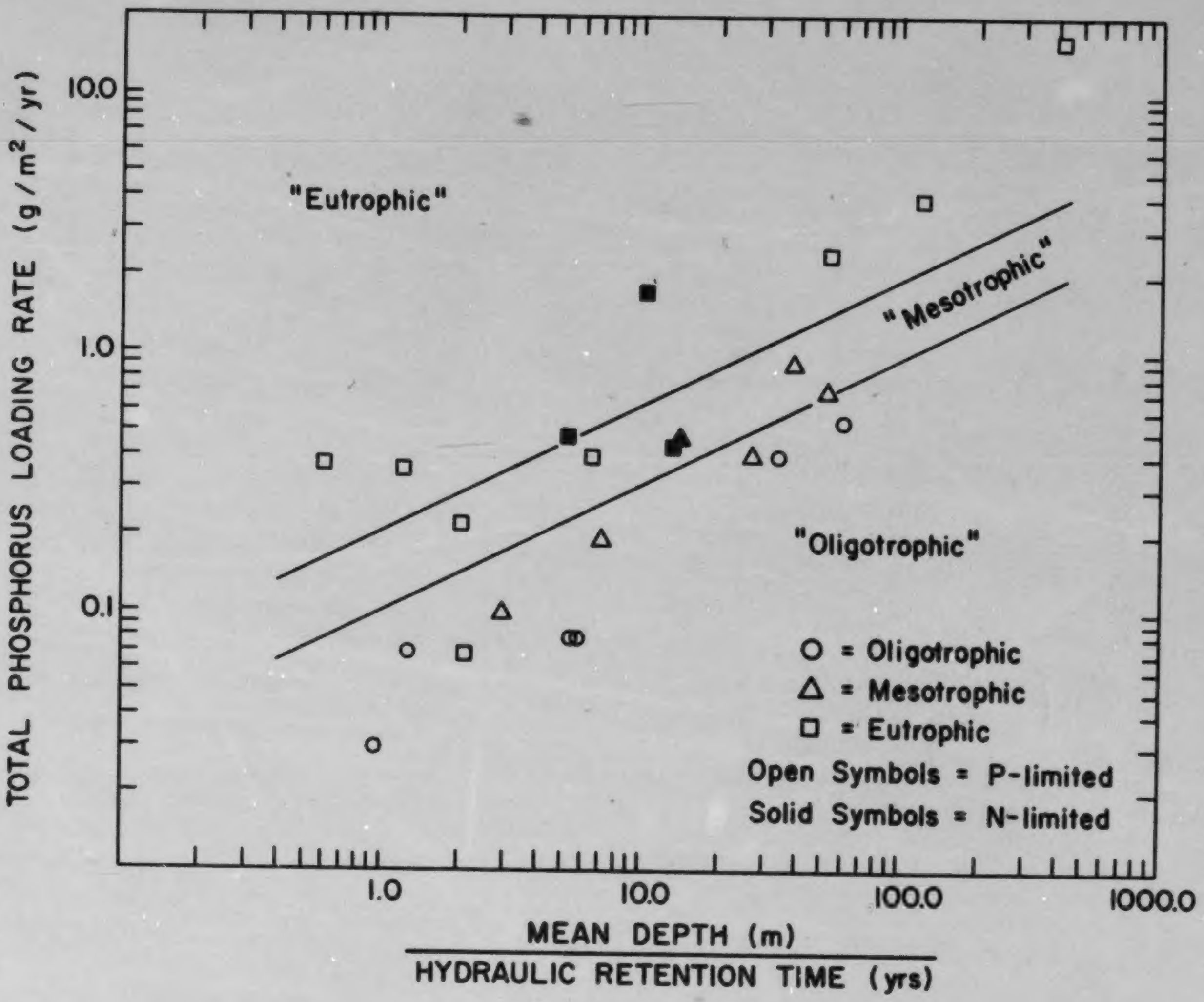
## FIGURE VI-5

## VOLLENWEIDER MODEL APPLIED TO 133 EASTER U.S. LAKES AND RESERVOIRS IMPACTED BY MUNICIPAL SEWAGE TREATMENT PLANT EFFLUENTS



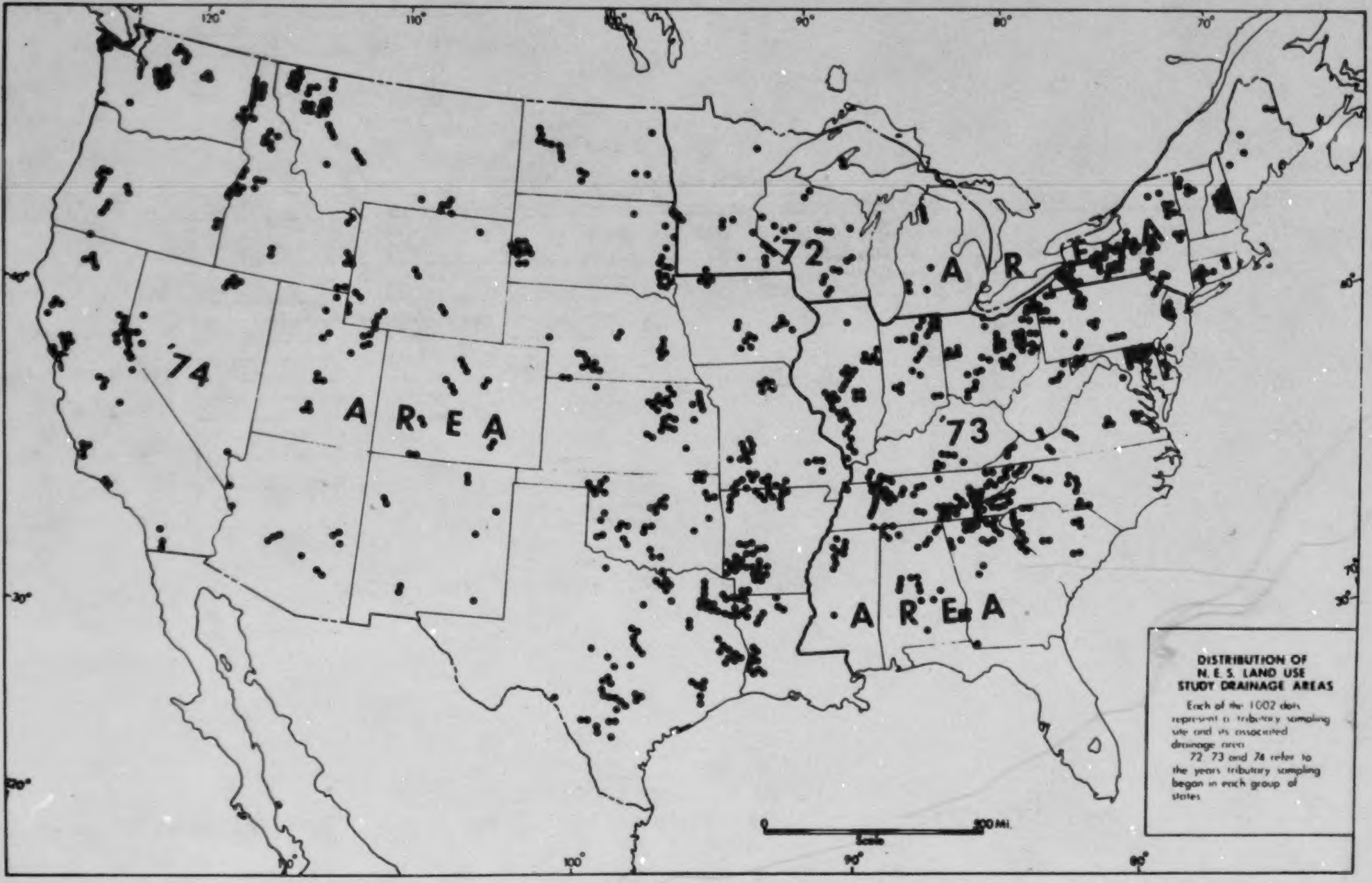
## FIGURE VI-6

VOLLENWEIDER MODEL APPLIED TO 23 EASTERN U.S. LAKES AND RESERVOIRS UNIMPACTED BY MUNICIPAL SEWAGE TREATMENT PLANT EFFLUENTS



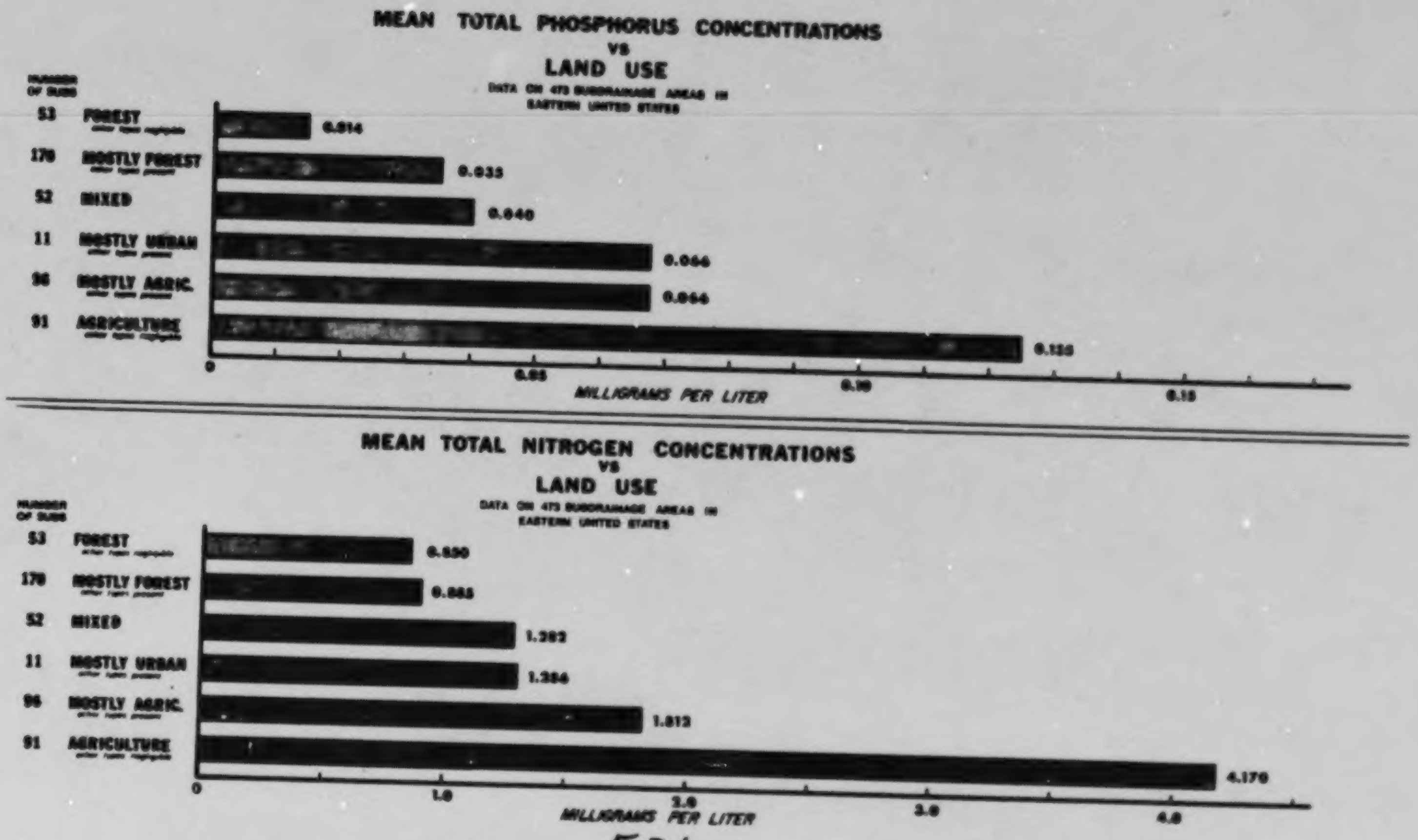
## FIGURE VI-7

## DISTRIBUTION OF STREAM SAMPLING SITES SELECTED FOR DRAINAGE AREA STUDIES BY NATIONAL EUTROPHICATION SURVEY


120°
110°
100°
90°
80°
70°
40°
30°
20°
'72 AREA
'73 AREA
'74 AREA
0
300 MI.
Scale
DISTRIBUTION OF N. E. S. LAND USE STUDY DRAINAGE AREAS
Each of the 1002 dots represent a tributary sampling site and its associated drainage area.
72, 73 and 74 refer to the years tributary sampling began in each group of states.

## FIGURE VI-8

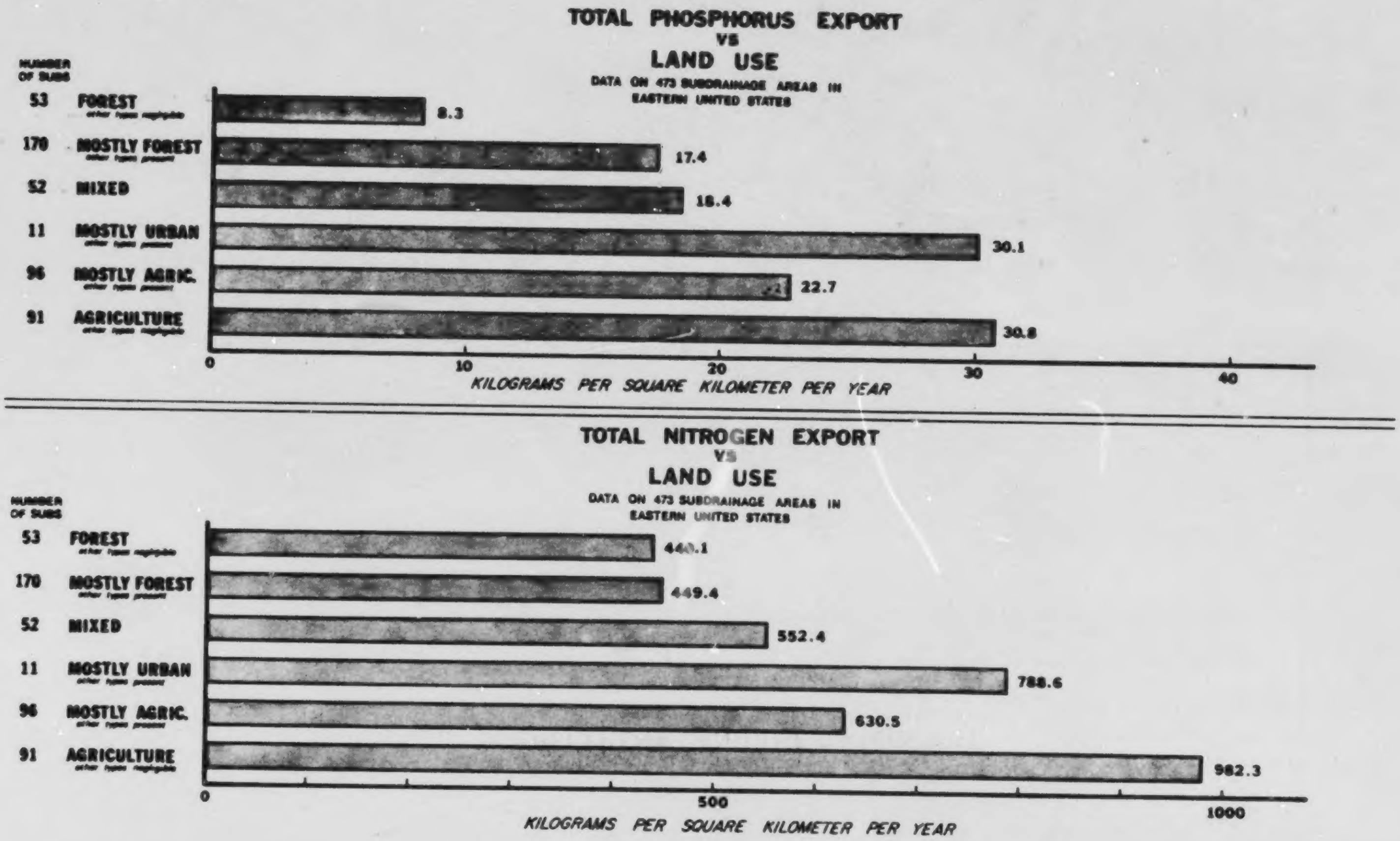
## MEAN TOTAL PHOSPHORUS AND TOTAL NITROGEN CONCENTRATIONS IN STREAMS DRAINING DIFFERENT LAND USE CATEGORIES



53/54

## FIGURE VI-9

## MEAN TOTAL PHOSPHORUS AND TOTAL NITROGEN EXPORT BY STREAMS DRAINING DIFFERENT LAND USE CATEGORIES



trations from these areas, because, on the average, rainfall per unit of forested area is greater than per unit of agricultural area. Stream flow and the percent of drainage area in forested land have a significant positive correlation.

### *Regionality*

The geographic distribution of land use characteristics, stream nutrient concentrations, and nutrient export values has been determined for the northeastern and north-central study areas. The northeastern (New England) states are characterized by relatively low stream nutrients, low nutrient export values, and a low ratio of agricultural to forested land areas. On the other hand, the northcentral States of Minnesota, Michigan, and Wisconsin are generally characterized by high nutrient concentrations, high nutrient export values, and a high ratio of agricultural to forested land areas. Similar determinations for other areas of the United States should be useful in revealing the regional patterns of surface-water nutrient levels and their relation to land use and other drainage area characteristics.

### *Soil Type and Stream Nutrients*

Preliminary analysis of relationships between soils and nutrient concentrations in streams has indicated significant correlations between pH characteristics in soils and nutrient concentrations, even within drainage areas having similar land uses. Generally, concentrations are higher in streams draining areas with soils characteristically high in bases (alkaline) than in streams draining areas with mostly acid-type soils.

### *Farm Animal Density and Stream Nutrients*

The analysis of data from the northeast and north-central study areas indicates that animal density in a watershed significantly influences stream nutrient levels. The relationships suggest that total phosphorus concentrations in streams draining areas with the same proportion of agricultural land use will increase approximately 28 percent with an increase of 25 animal units (equivalent to 25 beef cattle) per square kilometer. Total nitrogen concentrations will increase about 12 percent for the same increase in animal-unit density.

# APPENDIX A

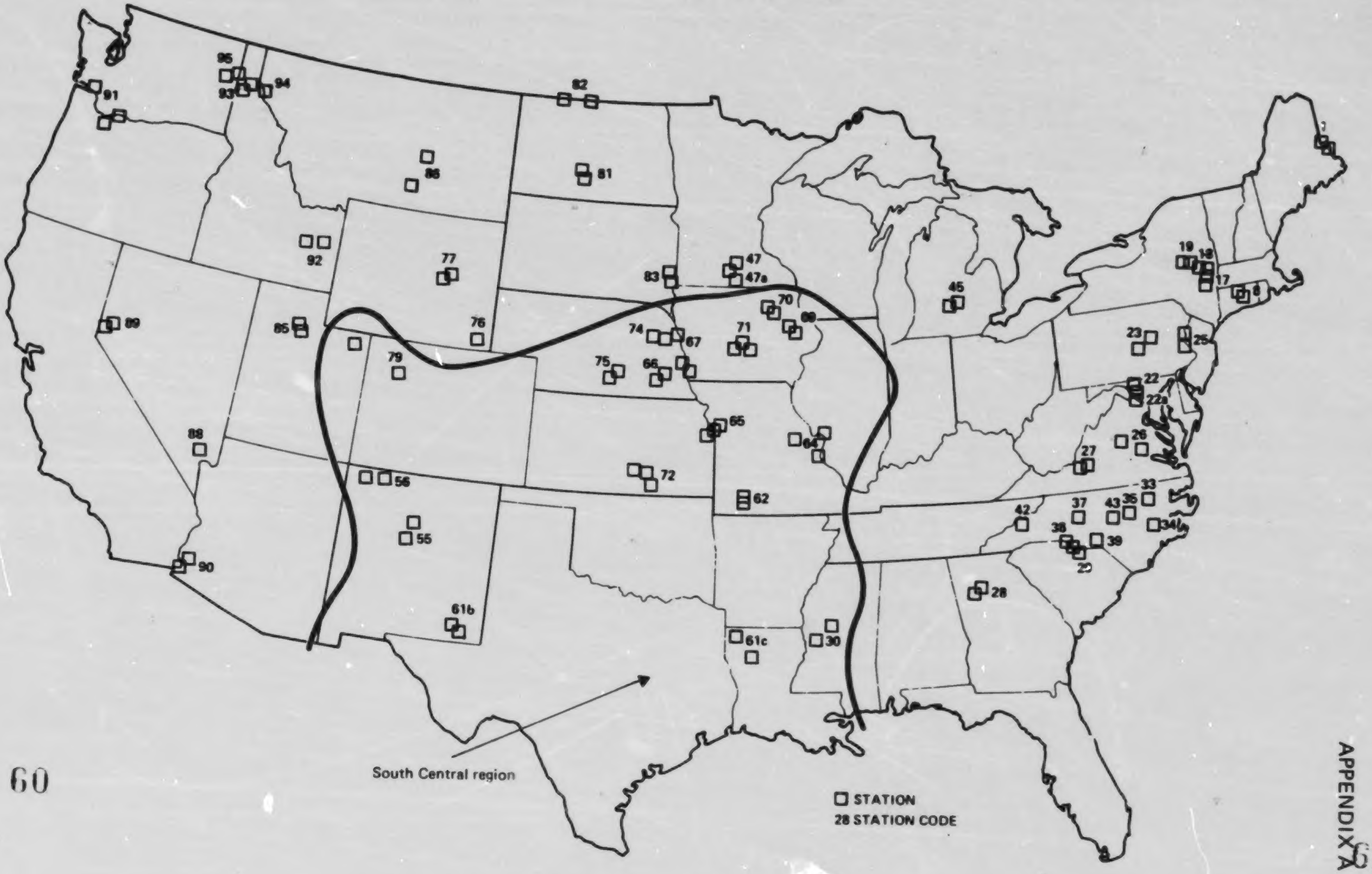
# National Water Quality Surveillance System

Appendix A provides a description of the 56 areas studied for the NWQSS analysis and presents the data for 19 water quality parameters measured in those areas.

Figure A-1 is a repeat of Figure V-1, which shows the station locations on a national map; the heavy line indicates the South-Central area of the country where the 1974 report found overall water quality characteristics to be different from those in the rest of the country. Table A-1 lists the station(s) and their location in each area. In addition, the drainage area, population density, and levels of manufacturing and agricultural activity are also provided for each area. For this analysis, high municipal/industrial activity areas were those with value added by manufacturing greater than $150,000 per square mile, and high agricultural activity areas were those with total farm products value greater than $15,000 per square mile. Table A-1 categorizes the areas by the size of the stream flowing through them. Large streams are defined as those with flows greater than 5,000 cfs; medium streams have flows between 1,000 and 5,000 cfs; and small streams have flows less than 1,000 cfs.

Table A-2 lists the stream sizes and parameters for the data shown in Figures A-2 through A-58. These figures graphically present the median, 15th percentile, and 85th percentile values for 19 water quality parameters. Each figure shows the data on one parameter for all areas within a stream size category. The areas in the South-Central portion of the country are listed separately to highlight geographical effects on water quality.

## FIGURE A-1
## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION CODE NUMBERS


95
91
93
94
82
86
81
92
77
47
47a
83
89
85
76
45
70
69
74
67
71
79
75
66
19
18
17
8
23
25
22
22a
88
65
64
26
27
56
72
62
33
42
37
43
35
34
55
38
39
29
90
28
61b
61c
30
1
South Central region
□ STATION
28 STATION CODE

## TABLE A-1

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM STATION AREA DESCRIPTIONS

(Large streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (persons/ square mile) | Value added by manufacturing ($000)/ square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 8 | | Connecticut River, CT | | | | | 435 | 1,191 | 673 | 24.9 | 10.9 |
| | A | upstream of Hartford | 41-46-36 | 72-39-29 | 112WRD | 01190069 | | | | | |
| | B | at Middle Haddam | 41-32-30 | 72-33-13 | 112WRD | 01193050 | | | | | |
| 17 | | Hudson River, NY | | | | | 416 | 621 | 601 | 3.0 | 11.0 |
| | A | at Glenmont | 42-35-43 | 73-45-43 | 112WRD | 01359560 | | | | | |
| | B | at Waterford | 42-47-38 | 73-40-24 | 112WRD | 01335770 | | | | | |
| | C | Mohawk River at Crescent | 42-48-22 | 73-43-24 | 112WRD | 01357000 | | | | | |
| 18 | | Mohawk River, NY | | | | | 114 | 955 | 1,857 | 2.6 | 8.8 |
| | A | at Crescent | 42-48-22 | 73-43-24 | 112WRD | 01357000 | | | | | |
| | B | at Schenectady | 42-49-07 | 73-56-59 | 112WRD | 01354490 | | | | | |
| 23 | | Susquehanna River, PA | | | | | 1010 | 234 | 349 | 5.7 | 10.1 |
| | A | near Hanlock Creek | 41-11-19 | 76-05-13 | 112WRD | 01537700 | | | | | |
| | B | at Danville | 10-57-29 | 76-37-10 | 112WRD | 01540500 | | | | | |
| 25 | | Delaware River, PA | | | | | 685 | 155 | 262 | 3.3 | 14.0 |
| | A | at East Stroudsburg | 41-02-40 | 75-01-42 | 112WRD | 01440090 | | | | | |
| | B | near Martin's Creek | 40-47-20 | 75-06-59 | 112WRD | 01446550 | | | | | |
| 26 | | James River, VA | | | | | 735 | 454 | 100 | 2.2 | 7.2 |
| | A | at Cartersville | 37-40-15 | 78-05-10 | 112WRD | 02035000 | | | | | |
| | B | near Dutch Gap | 37-23-26 | 77-21-49 | 112WRD | 02038700 | | | | | |
| 30 | | Yazoo River, MS | | | | | 3,626 | 50 | 35 | 29.0 | 1.9 |
| | A | near Yazoo | 32-51-29 | 90-26-07 | 112WRD | 072875000 | | | | | |
| | B | near Redwood | 32-29-16 | 90-49-00 | 112WRD | 07288800 | | | | | |
| 39 | | Pee Dee River, NC | | | | | 4,638 | 116 | 158 | 3.9 | 16.8 |
| | | near Rockingham | 34-56-46 | 79-52-11 | 112WRD | 02129000 | | | | | |

TABLE A-1 (Continued)

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION AREA DESCRIPTIONS

(Large streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (persons/square mile) | Value added by manufacturing ($000)/square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 61c | | Red River, LA | | | | | 1,758 | 159 | 75 | 1.8 | 4.5 |
| | A | upstream of Shreveport | 32-53-35 | 93-49-20 | 112WRD | 07344400 | | | | | |
| | B | downstream of Shreveport | 32-00-45 | 93-21-10 | 112WRD | 07350500 | | | | | |
| 64 | | Missouri and Mississippi Rivers, MO | | | | | 6,853 | 217 | 312 | 4.2 | 9.1 |
| | A | at Herman | 38-42-36 | 91-26-21 | 1117MBR | 000459 | | | | | |
| | B | downstream of St. Louis | 38-03-54 | 90-29-00 | 1117MBR | 000457 | | | | | |
| | C | at Alton, IL | 38-53-06 | 90-10-51 | 1117MBR | 000458 | | | | | |
| 65 | | Kansas River, KA and MO | | | | | 456 | 1,757 | 2,203 | 0.9 | 1.3 |
| | A | Kansas River | 39-06-00 | 94-42-00 | 1117MBR | 000462 | | | | | |
| | B | near Sugar Creek | 39-10-20 | 94-23-40 | 1117MBR | 000460 | | | | | |
| | C | Kansas City, MO | 39-06-00 | 94-35-16 | 1117MBR | 000461 | | | | | |
| 67 | | Platte and Missouri Rivers, NE | | | | | 1,011 | 474 | 658 | 14.5 | 82.6 |
| | A | near La Platte | 41-03-24 | 95-55-38 | 1117MBR | 000468 | | | | | |
| | B | near Plattsmouth | 41-00-04 | 95-51-59 | 1117MBR | 000466 | | | | | |
| | C | near Omaha | 41-20-37 | 95-57-26 | 1117MBR | 000467 | | | | | |
| 81 | | Missouri River, ND | | | | | 4,402 | 16 | 4 | 3.0 | 5.2 |
| | A | upstream of Bismarck | 46-58-51 | 100-49-12 | 112WRD | 06342500 | | | | | |
| | B | downstream of Bismarck | 46-39-22 | 100-44-18 | 112WRD | 06349700 | | | | | |
| 86 | | Yellowstone River, MT | | | | | 1,100 | 64 | 67 | 2.4 | 10.2 |
| | A | upstream of Billings | 45-41-37 | 108-38-25 | 112WRD | 06214100 | | | | | |
| | B | downstream of Billings | 46-54-15 | 108-19-01 | 112WRD | 06217500 | | | | | |

TABLE A-1 (Continued)

NATIONAL WATER QUALITY SURVEILLANCE SYSTEM,
STATION AREA DESCRIPTIONS
(Large streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (person/ square mile) | Value added by manufacturing ($000)/ square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 91 | | Columbia River, OR | | | | | 5,568 | 75 | 97 | 1.7 | 5.2 |
| | A | near Warrendale | 45-36-45 | 122-01-35 | 112WRD | 14128910 | | | | | |
| | B | at Bradwood | 46-11-29 | 123-26-04 | 112WRD | 14247400 | | | | | |
| | C | Willamette River at Portland, OR | | | 21400000 | 40200 | | | | | |
| 92 | | Snake River, ID | | | | | 210 | 19 | 3 | 15.8 | 7.3 |
| | A | upstream of Heise | 43-37-42 | 111-41-03 | 112WRD | 13037500 | | | | | |
| | B | east of Roberts | 42-00-00 | 112-00-00 | 112WRD | 13057100 | | | | | |
| 95 | | Spokane River, ID and WA | | | | | 730 | 286 | 197 | 8.2 | 5.6 |
| | A | below Post Falls Dam | 47-42-10 | 116-58-40 | 112WRD | 12419000 | | | | | |
| | B | at Riverside State Park | 47-41-48 | 117-29-48 | 112WRD | 12424200 | | | | | |

## TABLE A-1 (Continued)

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION AREA DESCRIPTIONS

(Medium streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (persons/ square mile) | Value added by manufacturing ($000)/ square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 1 | | St. Croix River, ME | | | | | 48 | 12 | 90 | 0.7 | 0.7 |
| | A | Grand Falls Dam | 45-16-34 | 67-23-48 | 11112300 | SCGP | | | | | |
| | B | Milltown | 45-10-11 | 67-17-50 | 112WRD | 01021050 | | | | | |
| 19 | | Mohawk River, NY | | | | | 90 | 377 | 680 | 2.5 | 31.1 |
| | A | at Lock 10 | 42-55-03 | 74-08-31 | 112WRD | 01354160 | | | | | |
| | B | at Tribes Hill | 42-56-42 | 74-17-21 | 112WRD | 01354000 | | | | | |
| 28 | | Chattahoochee River, GA | | | | | 642 | 1,012 | 1,274 | 0.6 | 9.1 |
| | A | at Road Paces Ferry | 33-51-33 | 84-27-16 | 112WRD | 02336000 | | | | | |
| | B | at State Road 2 | 33-39-24 | 84-40-25 | 112WRD | 02337170 | | | | | |
| 29 | | Catawba River, SC | | | | | 224 | 102 | 137 | 3.5 | 14.0 |
| | A | near Rock Hill | 34-59-05 | 80-58-27 | 112WRD | 02146000 | | | | | |
| | B | at Catawba | 34-51-09 | 88-52-06 | 112WRD | 02147000 | | | | | |
| 33 | | Tar River, NC<br>at Tarboro | 35-53-38 | 77-32-00 | 112WRD | 02083500 | 2,058 | 78 | 58 | 26.2 | 5.9 |
| 34 | | Neuse River, NC<br>at Kingston | 35-15-29 | 77-35-09 | 112WRD | 02089500 | 1,507 | 115 | 79 | 32.0 | 11.8 |
| 35 | | Neuse River, NC<br>at Clayton | 35-38-50 | 78-24-21 | 112WRD | 02087500 | 1,200 | 224 | 178 | 17.9 | 8.6 |
| 37 | | Yadkin River, NC<br>at Yadkin College | 35-51-24 | 80-23-10 | 112WRD | 02116500 | 2,450 | 143 | 398 | 9.2 | 23.5 |
| 42 | | French Broad River, NC<br>at Marshall | 35-47-10 | 82-39-39 | 112WRD | 03453500 | 1,313 | 139 | 210 | 4.6 | 8.7 |
| 43 | | Haw River, NC<br>near Haywood | 35-38-50 | 79-03-54 | 112WRD | 02098200 | 1,895 | 271 | 503 | 10.7 | 15.2 |

## TABLE A-1 (Continued)

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION AREA DESCRIPTIONS

(Medium streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (persons/square mile) | Value added by manufacturing ($000)/square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 55 | | Rio Grande River, NM | | | | | 3,100 | 96 | 27 | 0.2 | 2.3 |
| | A | at Angosture Diversion Dam | 35-22-45 | 106-29-40 | 21NMEX | MRG5 | | | | | |
| | B | at Isleta | 34-54-23 | 106-41-06 | 21NMEX | MRG61c | | | | | |
| 56 | | San Juan River, NM | | | | | 5,850 | 10 | 1 | 0.2 | 0.4 |
| | A | at Farmington | 36-41-12 | 108-05-27 | 21NMEX | SJR108 | | | | | |
| | B | at Shiprock | 36-46-32 | 108-41-32 | 21NMEX | SJR120 | | | | | |
| 69 | | Cedar River, IA | | | | | 568 | 251 | 624 | 16.0 | 48.0 |
| | A | at Palo | 42-03-00 | 91-46-31 | 1117MBR | 000481 | | | | | |
| | B | at Bertram | 41-55-33 | 91-33-02 | 1117MBR | 000480 | | | | | |
| 70 | | Cedar River, IA | | | | | 505 | 239 | 531 | 18.4 | 23.9 |
| | A | at Cedar Falls | 42-32-21 | 92-26-40 | 1117MBR | 000483 | | | | | |
| | B | at Gilbertville | 42-24-57 | 92-13-07 | 1117MBR | 000482 | | | | | |
| 71 | | Raccoon and Des Moines Rivers, IL | | | | | 282 | 770 | 1,036 | 16.5 | 23.9 |
| | A | Raccoon River at Van Meter | 41-32-02 | 93-56-59 | 1117MBR | 000479 | | | | | |
| | B | Des Moines R. near Des Moines | 41-33-06 | 93-31-28 | 1117MBR | 000477 | | | | | |
| | C | Des Moines R. at Saylorville | 41-40-50 | 93-40-07 | 1117MBR | 000478 | | | | | |
| 72 | | Little Arkansas and Ark. Rivers, KS | | | | | 424 | 711 | 1,317 | 10.0 | 13.5 |
| | A | Little Arkansas R. near Valley Center | 37-49-56 | 97-23-16 | 1117MBR | 000456 | | | | | |
| | B | Ark. R. near Derby | 37-22-34 | 97-16-31 | 1117MBR | 000454 | | | | | |
| | C | Ark. R. near Hutchinson | 37-56-47 | 97-46-29 | 1117MBR | 000455 | | | | | |

## TABLE A-1 (Continued)

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION AREA DESCRIPTIONS

(Medium streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (persons/square mile) | Value added by manufacturing ($000)/square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 77 | | North Platte River, WY | | | | | 294 | 136 | 75 | 0.1 | 1.4 |
| | A | upstream of Casper | 42-50-31 | 106-21-33 | 112WRD | 06644085 | | | | | |
| | B | downstream of Cooper | 42-51-45 | 106-13-00 | 112WRD | 06645000 | | | | | |
| 90 | | Colorado River, AZ and CA | | | | | 550 | 63 | 9 | 15.4 | 21.2 |
| | A | at Imperial Dam | 32-53-29 | 114-27-57 | 112WRD | 09429500 | | | | | |
| | B | at International Boundary | 32-43-07 | 114-43-05 | 112WRD | 09522000 | | | | | |
| 93 | | St. Joe's River, ID | | | | | 1,700 | 8 | 10 | 0.8 | 0.4 |
| | | Stridge at St. Maries | 47-19-02 | 116-33-38 | 112WRD | 12415075 | | | | | |
| 94 | | Coeur d'Alene River, ID | | | | | 1,551 | 14 | 15 | 0.9 | 0.6 |
| | A | near Mullan | 47-28-15 | 115-46-22 | 112WRD | 12413080 | | | | | |
| | B | Bridge at Rose Lake | 47-32-14 | 116-28-17 | 112WRD | 12413810 | | | | | |

## TABLE A-1 (Continued)

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION AREA DESCRIPTIONS

(Small streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (person/ square mile) | Value added by manufacturing ($000)/ square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 22 | | Monocacy River, MD | | | | | 360 | 116 | 138 | 9.3 | 39.1 |
| | A | at Bridge Port | 39-40-43 | 77-14-06 | 112WRD | 01639000 | | | | | |
| | B | at Briggs Ford Branch | | | 112WRD | 01641810 | | | | | |
| 22a | | Monocacy River, MD | | | | | 262 | 196 | 117 | 4.9 | 41.6 |
| | B | at Briggs Ford Branch | | | 112WRD | 01641810 | | | | | |
| | C | at Reigh Ford Branch | 39-23-16 | 77-22-40 | 112WRD | 01643020 | | | | | |
| 27 | | Roanoke River, VA | | | | | 259 | 593 | 708 | 2.4 | 7.8 |
| | A | at Lafayette | 37-14-11 | 80-12-34 | 112WRD | 02054500 | | | | | |
| | B | at Roanoke | 37-15-30 | 79-56-20 | 112WRD | 02055000 | | | | | |
| 38 | | Sugar Creek, NC | | | | | 265 | 1,068 | 1,250 | 2.4 | 3.8 |
| | | near Fort Mill | 35-00-21 | 80-54-09 | 112WRD | 02146800 | | | | | |
| 45 | | Grand River, MI | | | | | 477 | 504 | 1,244 | 6.6 | 18.8 |
| | A | at Lansing Waverly Road Bridge | 42-42-33 | 84-36-10 | 21MICH | 230038 | | | | | |
| | B | at Webster Road Bridge | 42-46-05 | 84-40-08 | 21MICH | 230028 | | | | | |
| 47 | | Blue Earth River, MN | | | | | 975 | 32 | 25 | 25.7 | 34.3 |
| | A | 100 miles from mouth | 43-34-22 | 94-06-08 | 21MINN | MNBE 100-BB15E67 | | | | | |
| | C | northwest of Winnebago | 43-49-59 | 94-10-13 | 21MINN | MNBE 63-BB15E55 | | | | | |
| 47a | | Blue Earth River, MN | | | | | 2,376 | 43 | 50 | 21.6 | 26.9 |
| | C | northwest of Winnebago | 43-49-59 | 94-10-13 | 21MINN | MNBE 63-BB15E55 | | | | | |
| | B | at mouth | 44-09-47 | 94-02-20 | 21MINN | MNBE 00-BB15E67 | | | | | |

## TABLE A-1 (Continued)

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION AREA DESCRIPTIONS

(Small streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (person/ square mile) | Value added by manufacturing ($000)/ square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 61b | | Pecos River, NM | | | | | 241 | 89 | 17 | 0.1 | 0.3 |
| | A | above Carlsbad | 32-28-55 | 104-15-47 | 21NMEX | LPR200 | | | | | |
| | B | 6 miles below Carlsbad | 32-23-00 | 104-08-30 | 21NMEX | LPR206 | | | | | |
| 62 | | James River, MO | | | | | 139 | 317 | 357 | 1.0 | 16.5 |
| | A | near Wilson Creek | 37-04-35 | 93-22-15 | 1117MBR | 000451 | | | | | |
| | B | near Boaz | 37-00-25 | 93-21-50 | 1117MBR | 000450 | | | | | |
| 66 | | Salt Creek, NE | | | | | 565 | 287 | 278 | 16.0 | 23.4 |
| | A | above Beal Slough | 40-46-13 | 96-43-05 | 1117MBR | 000472 | | | | | |
| | B | near Waverly | 40-54-18 | 96-35-09 | 1117MBR | 000471 | | | | | |
| 74 | | Elkhorn River, NE | | | | | 469 | 16 | 2 | 9.4 | 125.1 |
| | A | at Stenton | 41-50-25 | 97-13-06 | 1117MBR | 000470 | | | | | |
| | B | at West Point | 41-50-30 | 96-42-24 | 1117MBR | 000469 | | | | | |
| 75 | | Wood River, NE | | | | | 47 | 681 | 873 | 16.1 | 51.4 |
| | A | at Aida | 40-51-10 | 98-28-20 | 1117MBR | 000474 | | | | | |
| | B | near Grand Island | 40-56-05 | 98-16-56 | 1117MBR | 000473 | | | | | |
| 79 | | White River, CO and UT | | | | | 4,075 | 2 | 0.2 | 0.2 | 1.4 |
| | A | downstream of Meeker, CO | 40-00-08 | 108-05-23 | 112WRD | 09304800 | | | | | |
| | B | near Ouray, UT | 40-03-54 | 109-38-08 | 112WRD | 09306900 | | | | | |
| 76 | | Crow Creek, WY<br>downstream of Cheyenne | 41-07-09 | 104-45-33 | 112WRD | 06756000 | 275 | 153 | 25 | 0.9 | 3.0 |
| 82 | | Souris River, ND | | | | | 6,225 | 12 | 2 | 6.7 | 2.4 |
| | A | near Canadian border | 48-59-24 | 101-57-28 | 112WRD | 05114000 | | | | | |
| | B | near West Hope | 48-59-47 | 100-57-29 | 112WRD | 05124000 | | | | | |

## TABLE A-1 (Continued)

## NATIONAL WATER QUALITY SURVEILLANCE SYSTEM, STATION AREA DESCRIPTIONS

(Small streams)

| Station Code | | River and location | Latitude | Longitude | Agency code | Station number | Drainage area (square miles) | Population density (person/square mile) | Value added by manufacturing ($000)/square mile) | Farm product value ($000/square mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Crops | Livestock |
| 83 | | Big Sioux River, SD | | | | | 576 | 153 | 113 | 9.5 | 43.3 |
| | A | upstream of Sioux Falls | 43-47-25 | 96-44-42 | 112WRD | 06481000 | | | | | |
| | B | downstream of Sioux Falls | 43-34-01 | 96-42-39 | 112WRD | 06482020 | | | | | |
| 85 | | Jordan River, UT | | | | | 192 | 1,143 | 1,191 | 3.5 | 10.0 |
| | A | upstream of Salt Lake City | 40-38-43 | 111-55-18 | 112WRD | 10167300 | | | | | |
| | B | downstream of Salt Lake City | 40-50-31 | 111-57-01 | 112WRD | 10172600 | | | | | |
| 88 | | Las Vegas Wash, NV near Lake Mead | 36-07-20 | 114-54-15 | 112WRD | 09419800 | 171 | 950 | 275 | 0.1 | 0.2 |
| 89 | | Truckee River, CA and NV | | | | | 358 | 208 | 74 | 0.1 | 0.3 |
| | A | at Farad, CA | 39-25-41 | 120-01-59 | 112WRD | 10346000 | | | | | |
| | B | Lockwood Bridge at Vista | 39-30-42 | 119-38-48 | 112WRD | 10350050 | | | | | |

## TABLE A-2
## LIST OF DATA FIGURES

| Figure number | Stream size | Parameter | Parameter number |
|---|---|---|---|
| A-2 | Large | Conductivity | 95 |
| A-3 | Large | Total copper | 1042 |
| A-4 | Large | Total iron | 1045 |
| A-5 | Large | Total lead | 1051 |
| A-6 | Large | Total manganese | 1055 |
| A-7 | Large | Total zinc | 1092 |
| A-8 | Large | Turbidity | 70 |
| A-9 | Large | Total suspended solids | 530,70299 |
| A-10 | Large | Total dissolved solids | 515,70300 |
| A-11 | Large | Chloride | 940 |
| A-12 | Large | Sulfate | 945 |
| A-13 | Large | Ammonia | 610 |
| A-14 | Large | Total Kjeldahl nitrogen | 625 |
| A-15 | Large | Nitrites plus nitrates | 630 |
| A-16 | Large | Total phosphorus | 665 |
| A-17 | Large | Dissolved oxygen | 300 |
| A-18 | Large | Chemical oxygen demand | 335,340 |
| A-19 | Large | Total organic carbon | 680 |
| A-20 | Large | Fecal coliform bacteria | 31616 |
| A-21 | Medium | Conductivity | 95 |
| A-22 | Medium | Total copper | 1042 |
| A-23 | Medium | Total iron | 1045 |
| A-24 | Medium | Total lead | 1051 |
| A-25 | Medium | Total manganese | 1055 |
| A-26 | Medium | Total zinc | 1092 |
| A-27 | Medium | Turbidity | 70 |
| A-28 | Medium | Total suspended solids | 530,70299 |
| A-29 | Medium | Total dissolved solids | 515,70300 |
| A-30 | Medium | Chloride | 940 |
| A-31 | Medium | Sulfate | 945 |
| A-32 | Medium | Ammonia | 610 |
| A-33 | Medium | Total Kjeldahl nitrogen | 625 |
| A-34 | Medium | Nitrites plus nitrates | 630 |
| A-35 | Medium | Total phosphorus | 665 |
| A-36 | Medium | Dissolved oxygen | 300 |
| A-37 | Medium | Chemical oxygen demand | 335,340 |
| A-38 | Medium | Total organic carbon | 680 |
| A-39 | Medium | Fecal coliform bacteria | 31616 |
| A-40 | Small | Conductivity | 95 |
| A-41 | Small | Total copper | 1042 |
| A-42 | Small | Total iron | 1045 |
| A-43 | Small | Total lead | 1051 |
| A-44 | Small | Total manganese | 1055 |
| A-45 | Small | Total zinc | 1092 |
| A-46 | Small | Turbidity | 70 |
| A-47 | Small | Total suspended solids | 530,70299 |
| A-48 | Small | Total dissolved solids | 515,70300 |
| A-49 | Small | Chloride | 940 |
| A-50 | Small | Sulfate | 945 |
| A-51 | Small | Ammonia | 610 |
| A-52 | Small | Total Kjeldahl nitrogen | 625 |
| A-53 | Small | Nitrites plus nitrates | 630 |
| A-54 | Small | Total phosphorus | 665 |
| A-55 | Small | Dissolved oxygen | 300 |
| A-56 | Small | Chemical oxygen demand | 335,340 |
| A-57 | Small | Total organic carbon | 680 |
| A-58 | Small | Fecal coliform bacteria | 31616 |

Figure A-2

## CONDUCTIVITY LEVELS FOR STATIONS ON LARGE STREAMS

1974

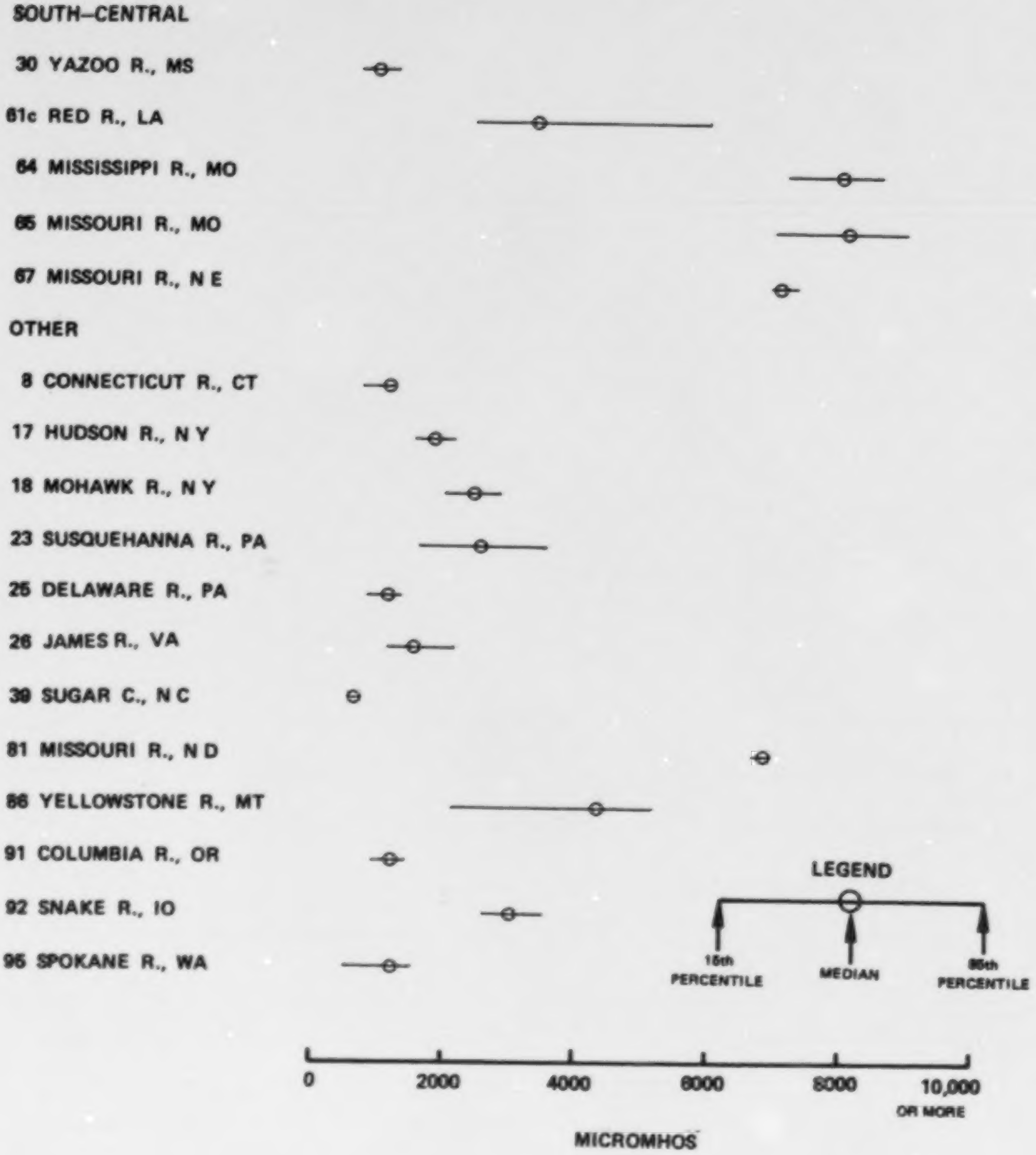


Figure A-3
TOTAL COPPER CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

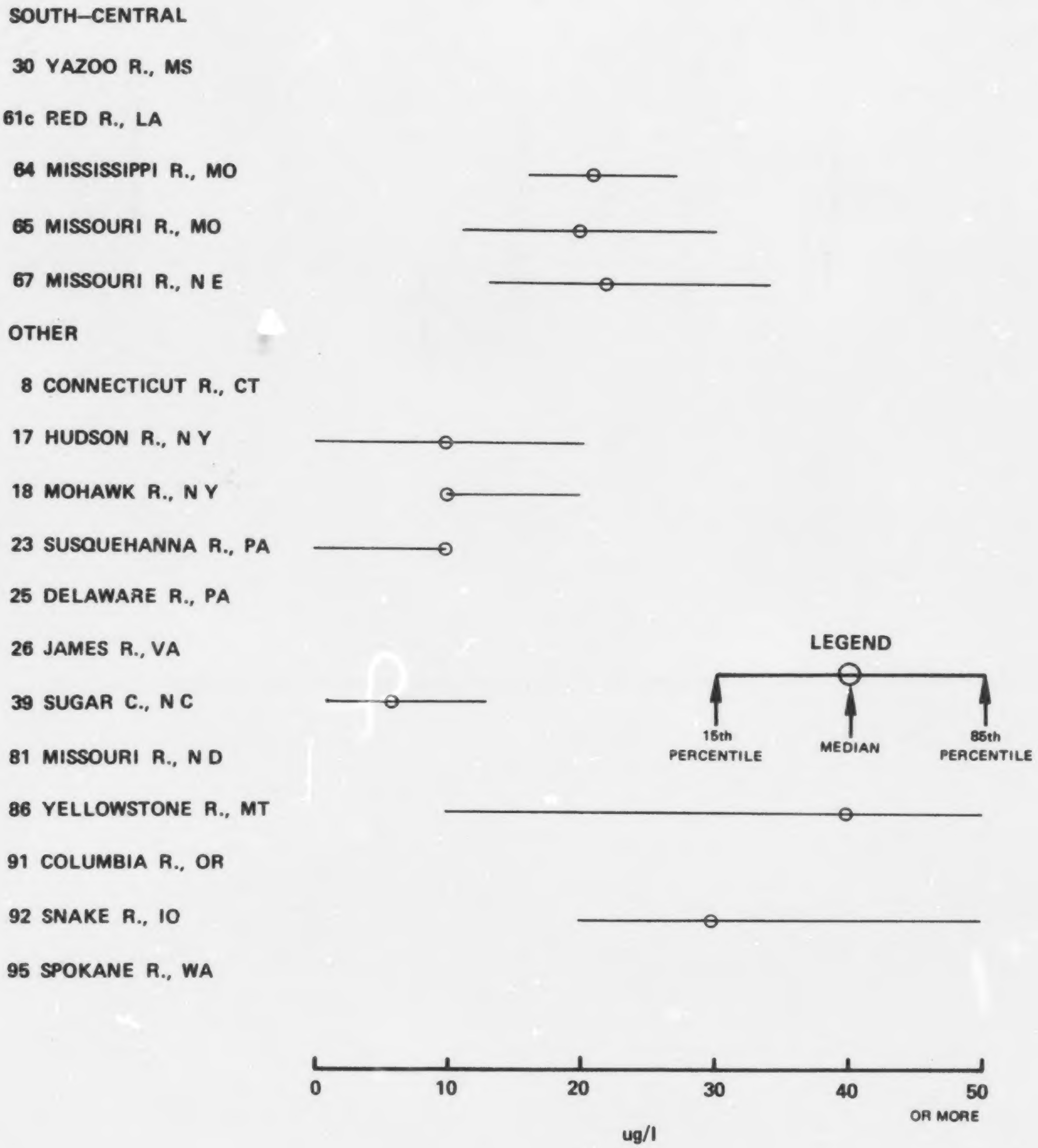


Figure A-4

TOTAL IRON CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS

1974

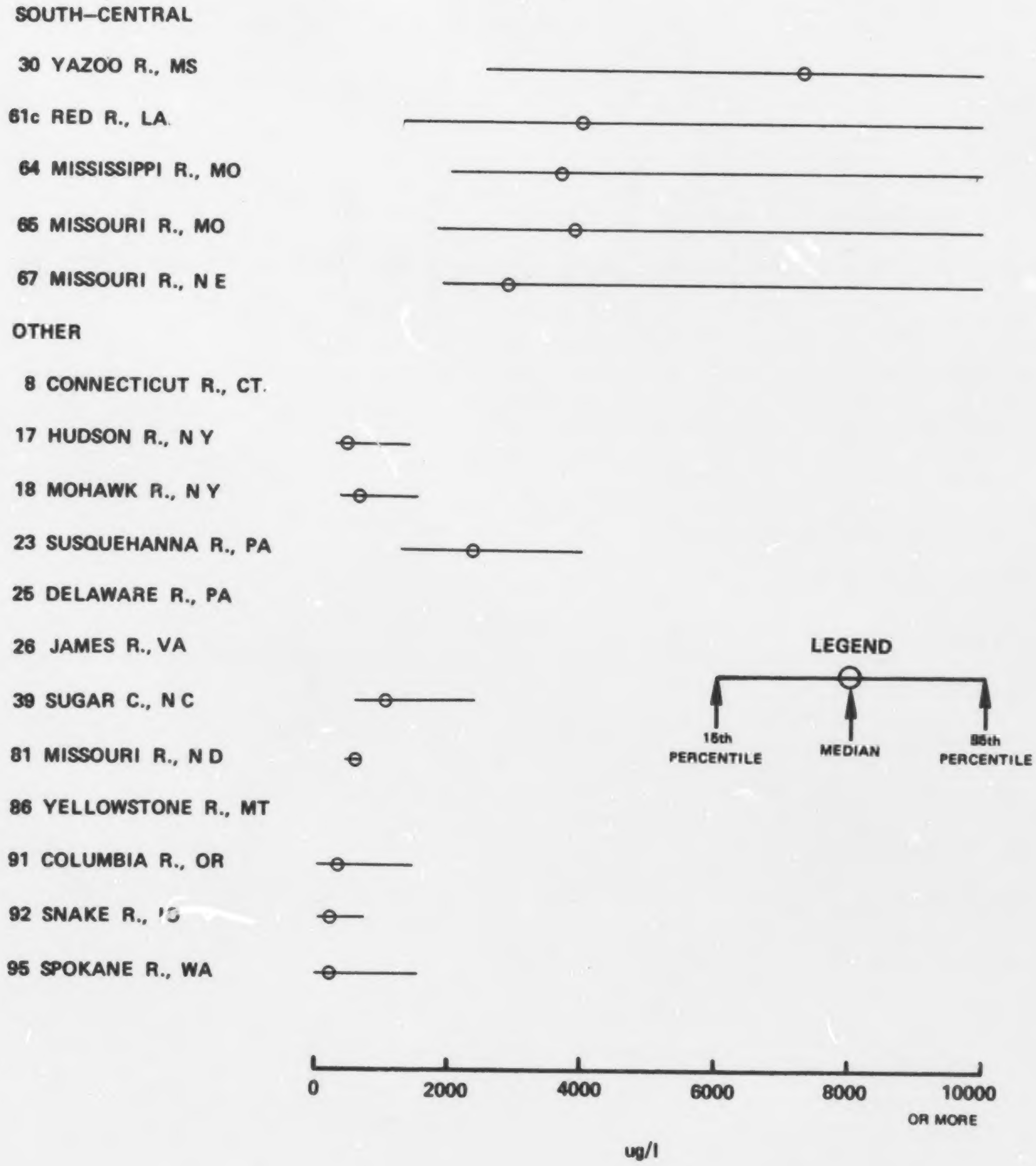


Figure A-5

TOTAL LEAD CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

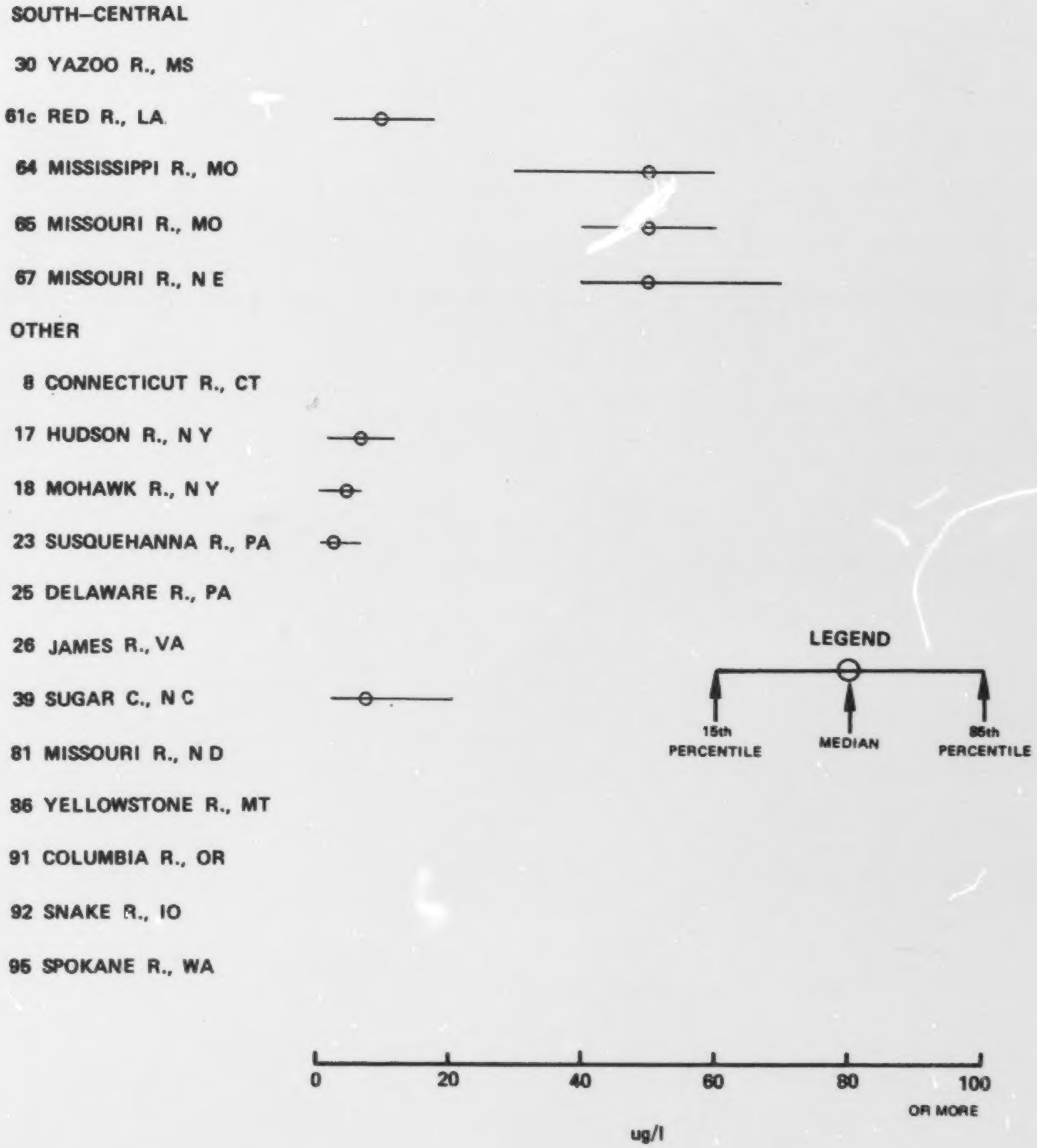


Figure A-6
TOTAL MANGANESE CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

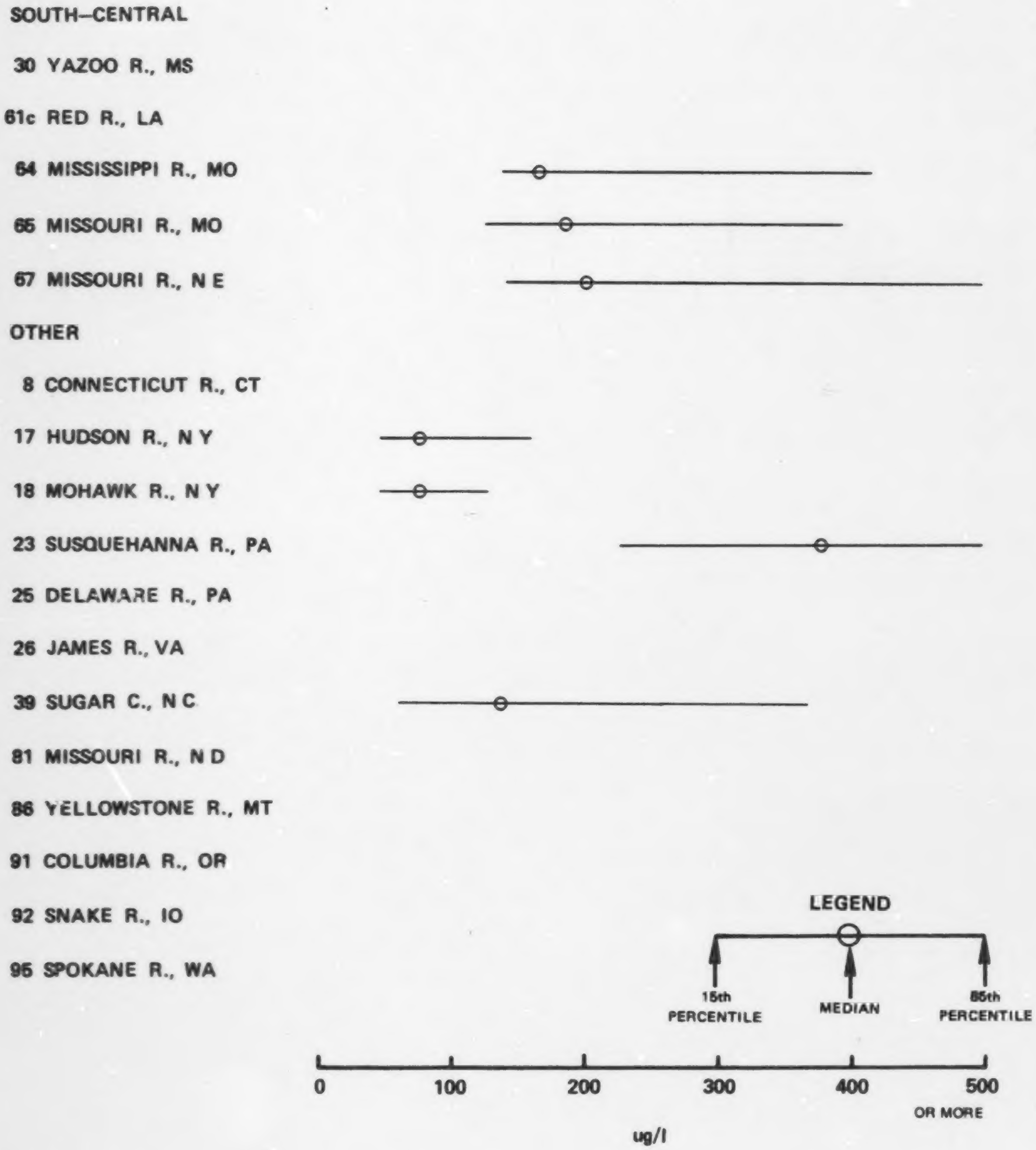


Figure A-7

TOTAL ZINC CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

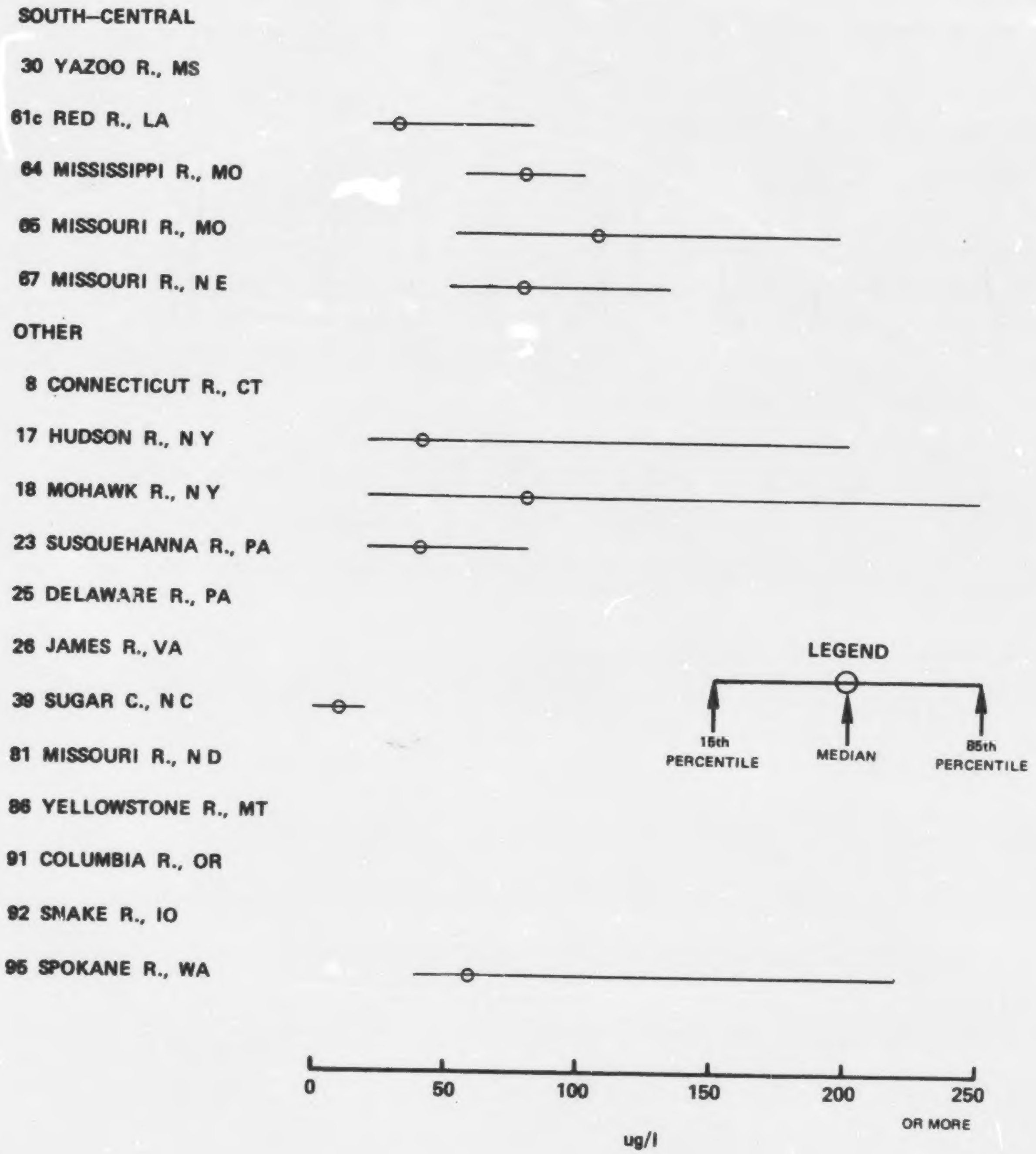


Figure A-8

TURBIDITY LEVELS
FOR
STATIONS ON LARGE STREAMS
1974

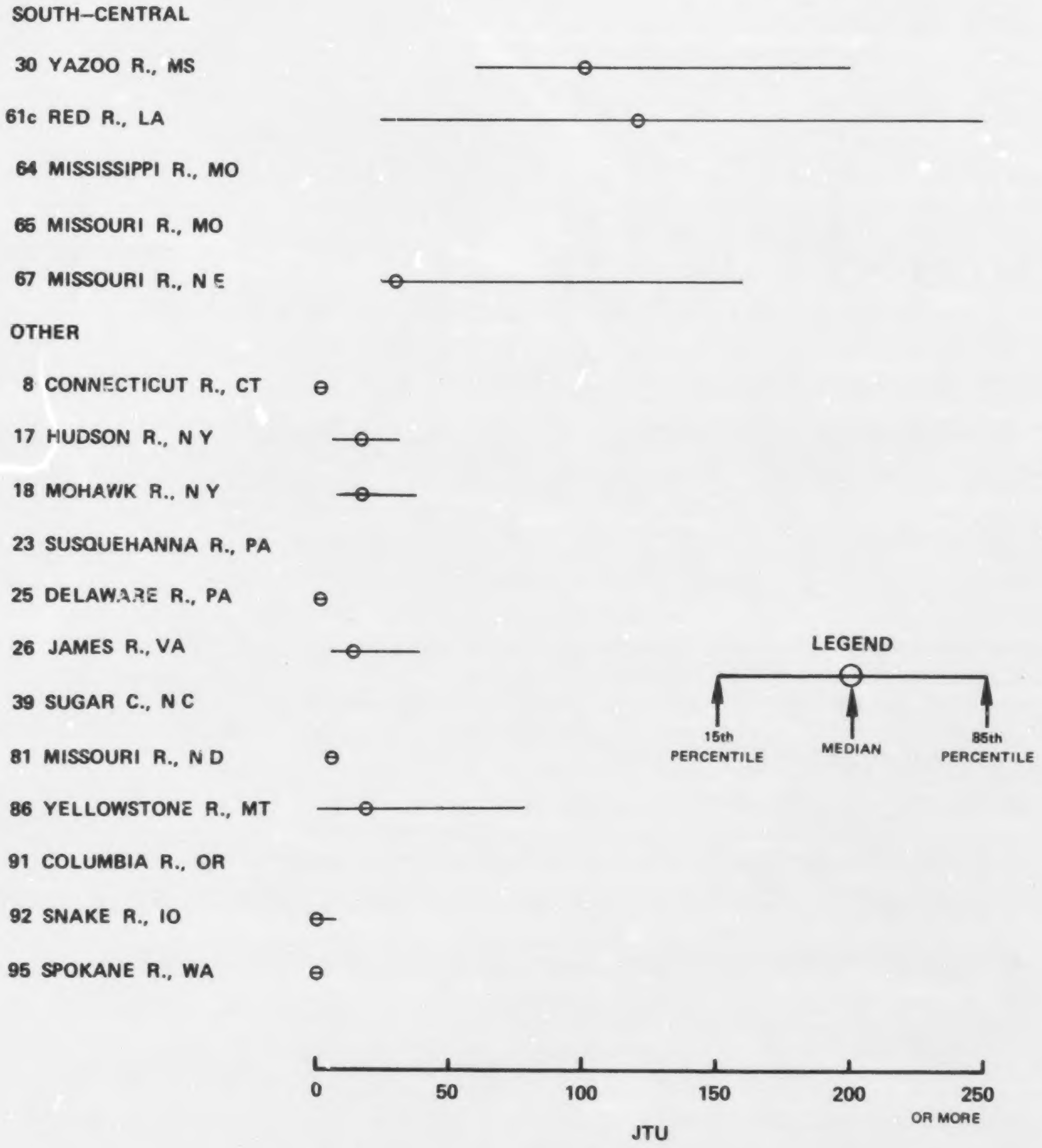


Figure A-9

TOTAL SUSPENDED SOLID CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

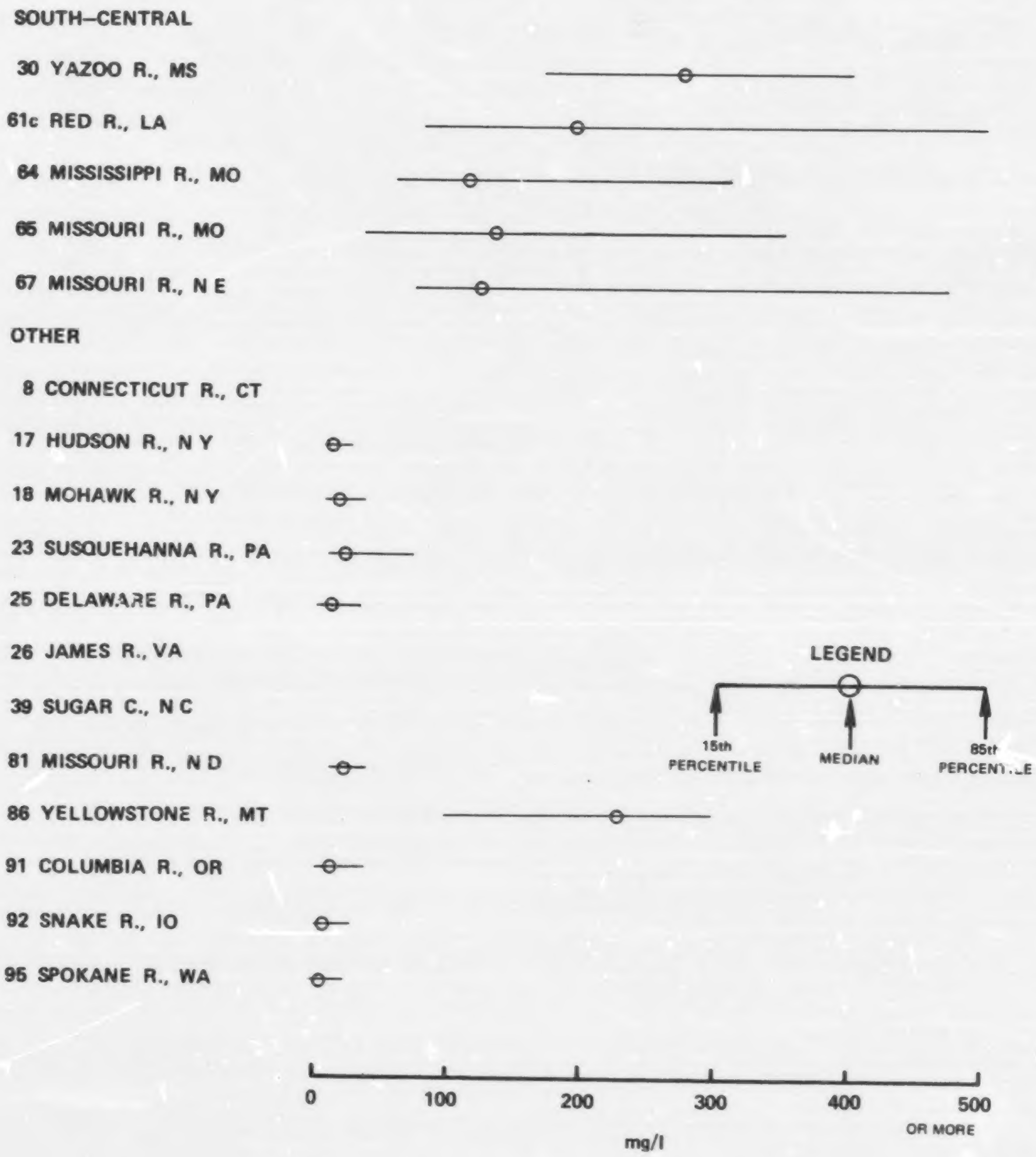


Figure A-10

### TOTAL DISSOLVED SOLID CONCENTRATIONS FOR STATIONS ON LARGE STREAMS

1974

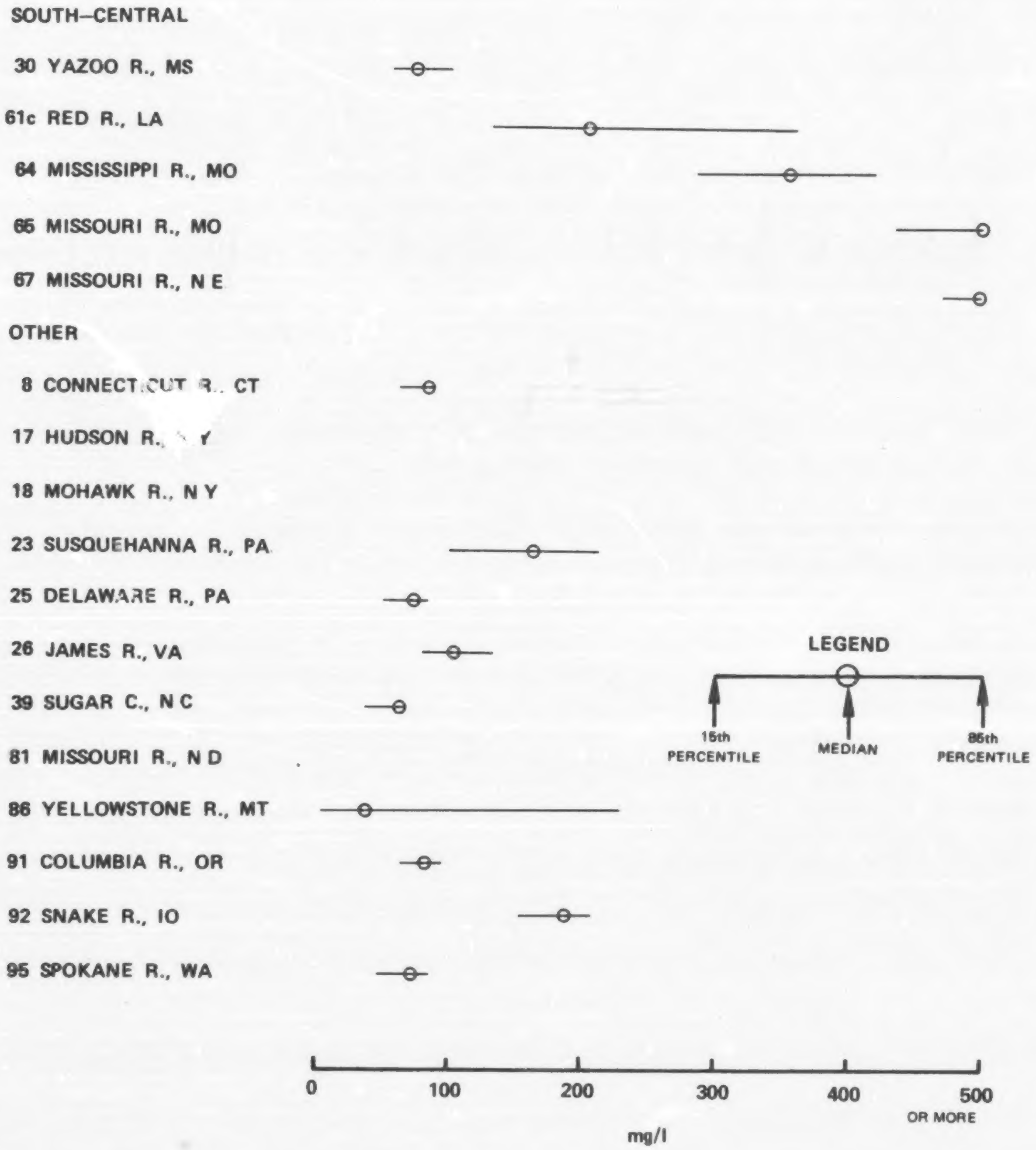


Figure A-11

CHLORIDE CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

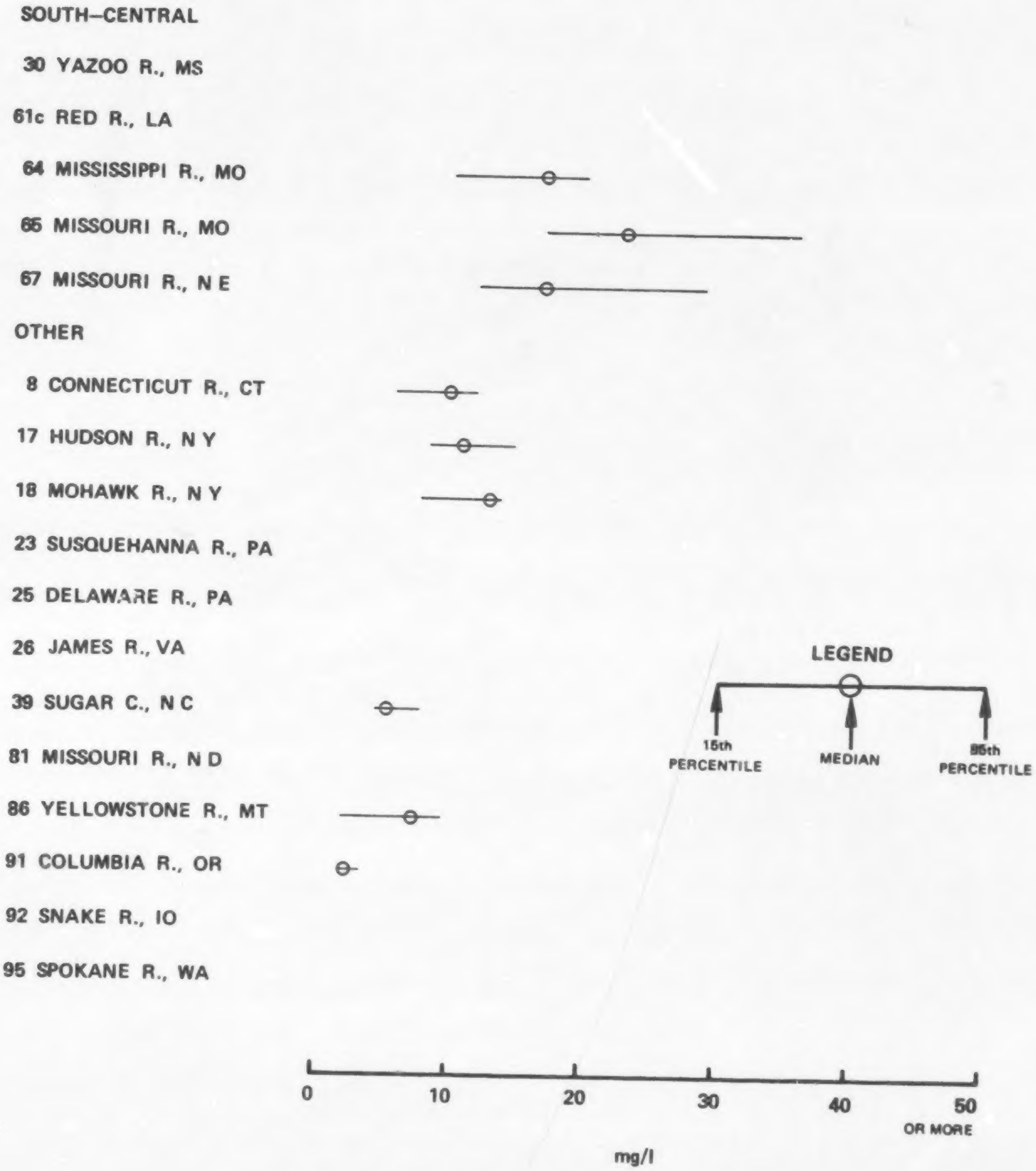


Figure A-12

TOTAL SULFATE CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

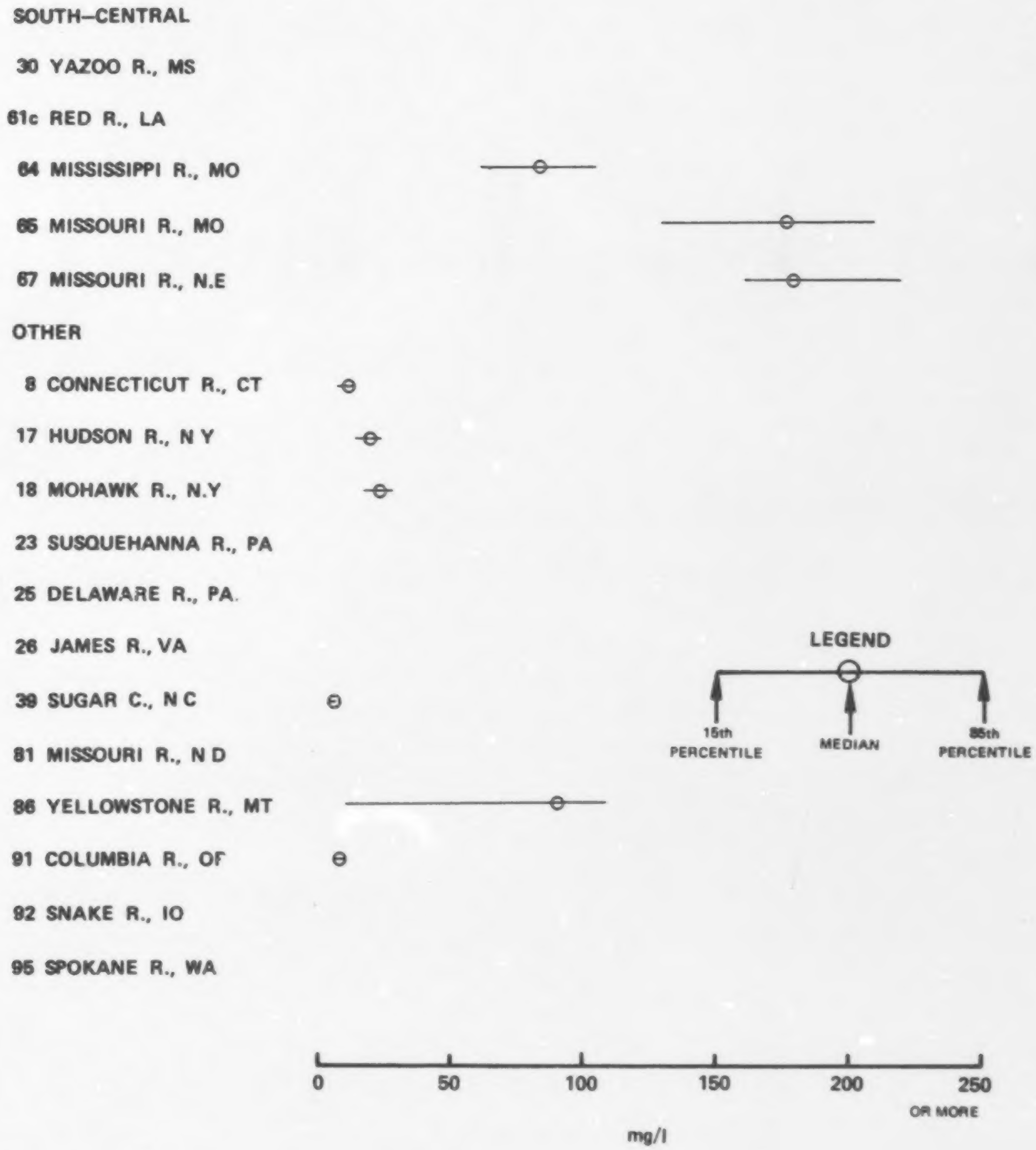


Figure A-13

TOTAL AMMONIA CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

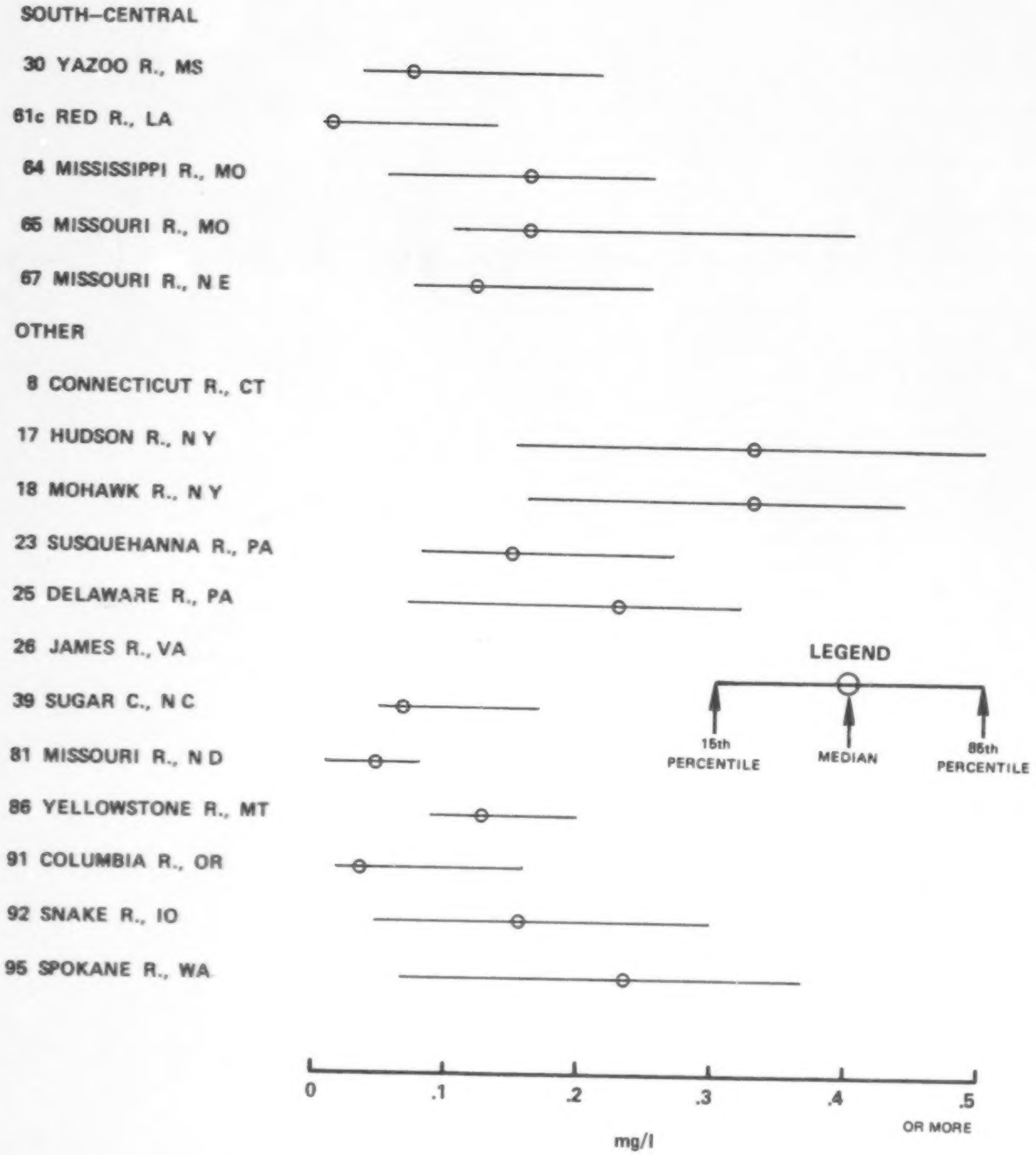


Figure A-14

TOTAL KJELDAHL NITROGEN CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

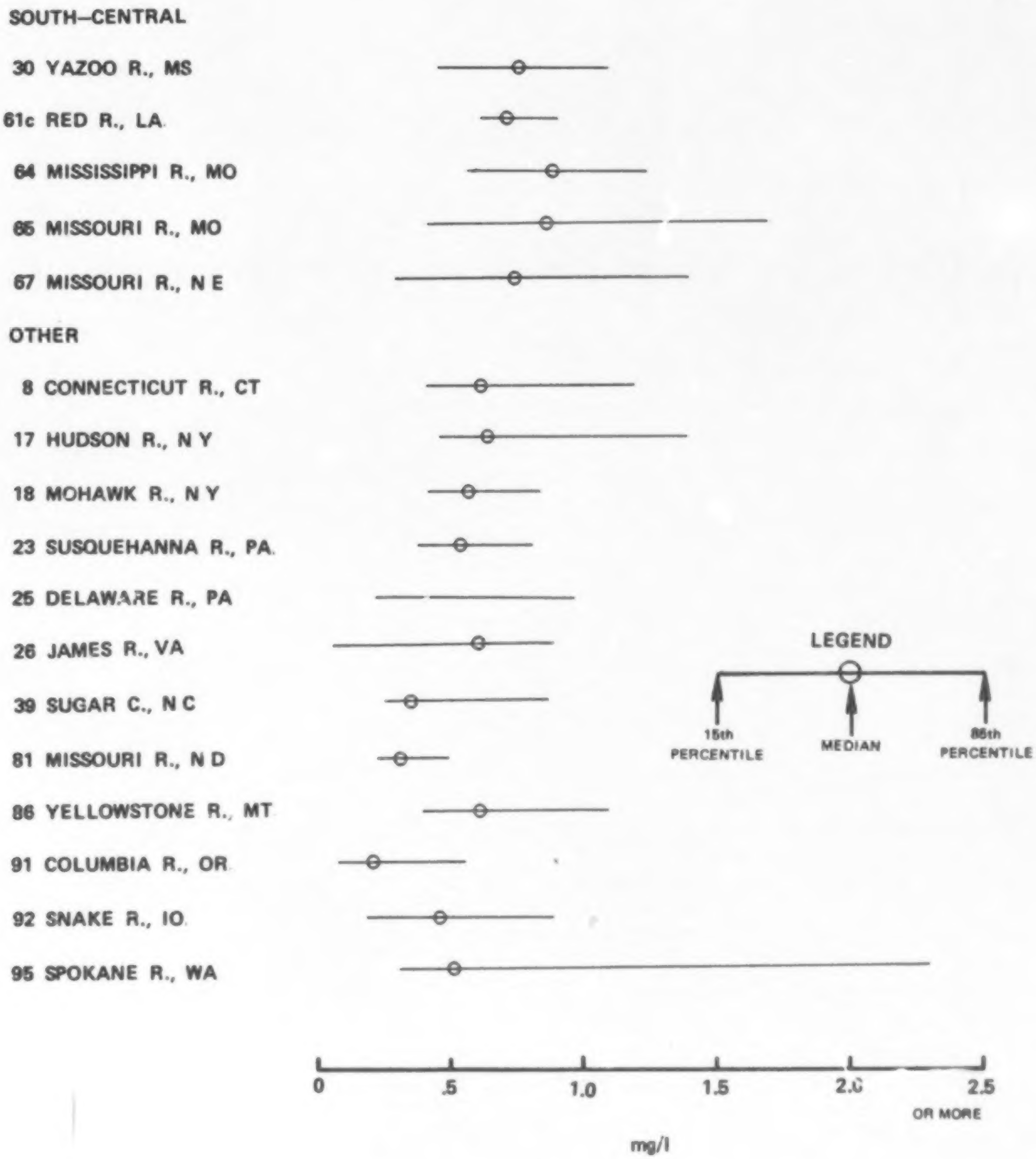


Figure A-15

TOTAL NITRATE PLUS NITRITE CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

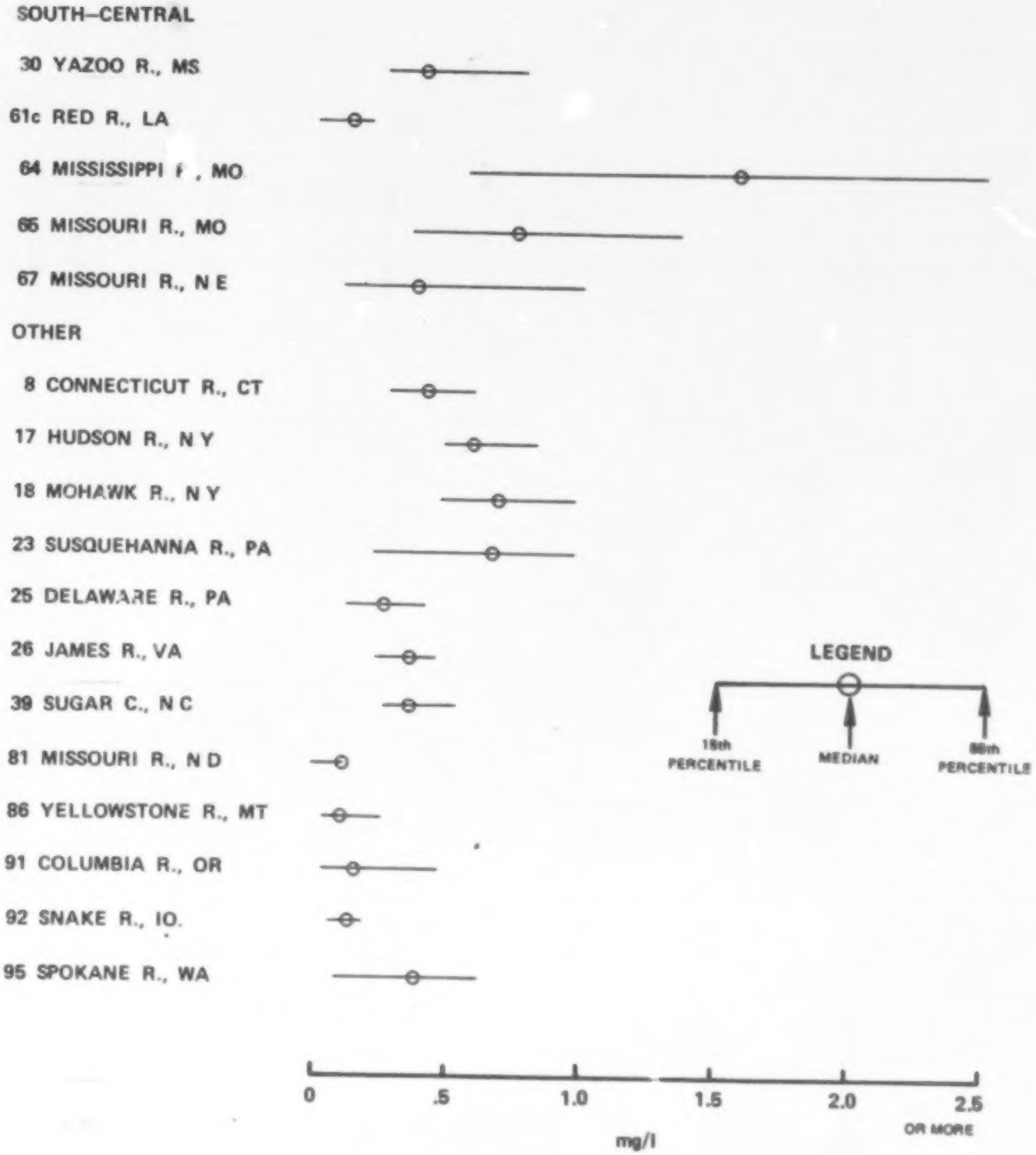


Figure A-16

TOTAL PHOSPHORUS CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

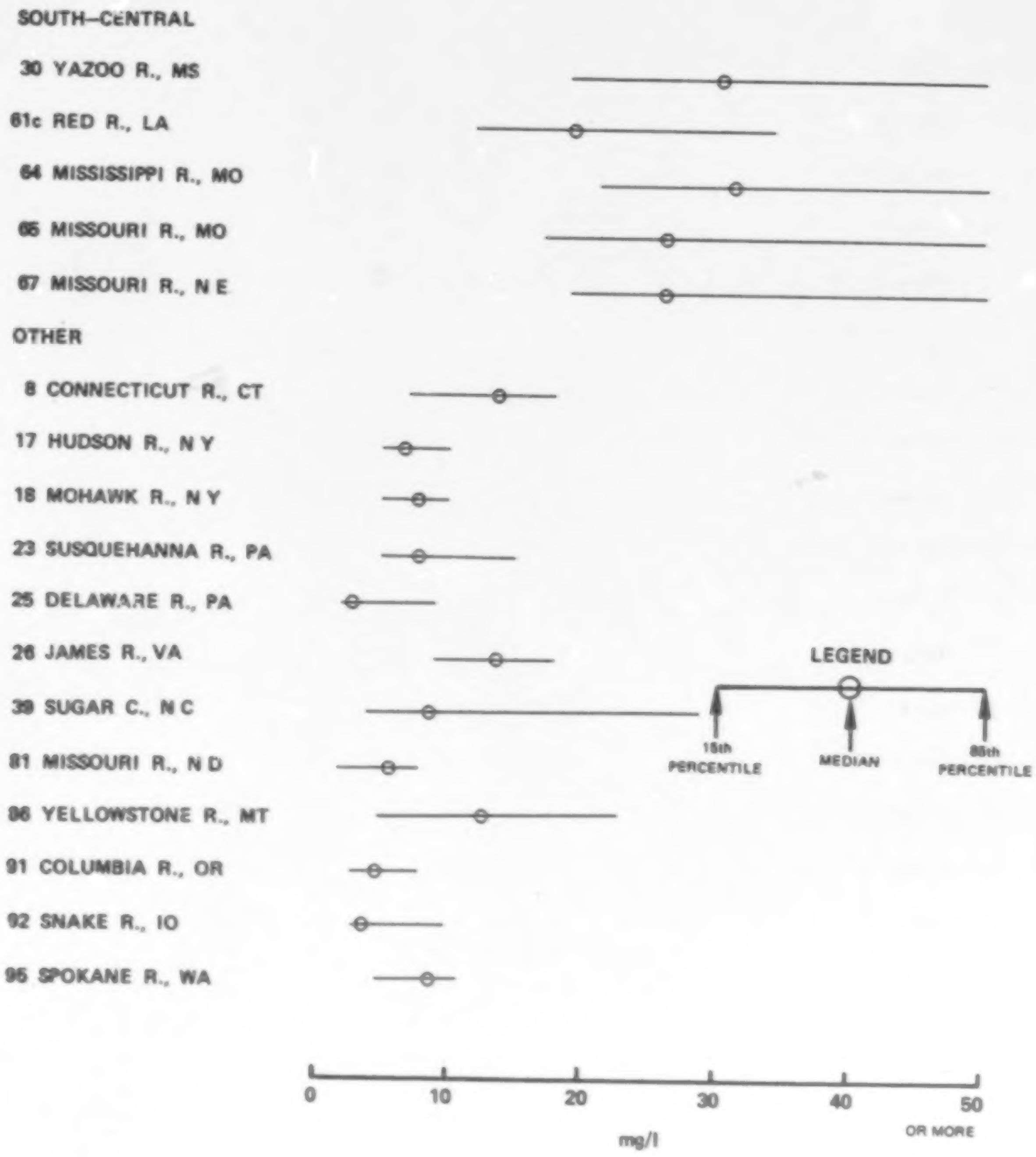


Figure A-17

DISSOLVED OXYGEN CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974

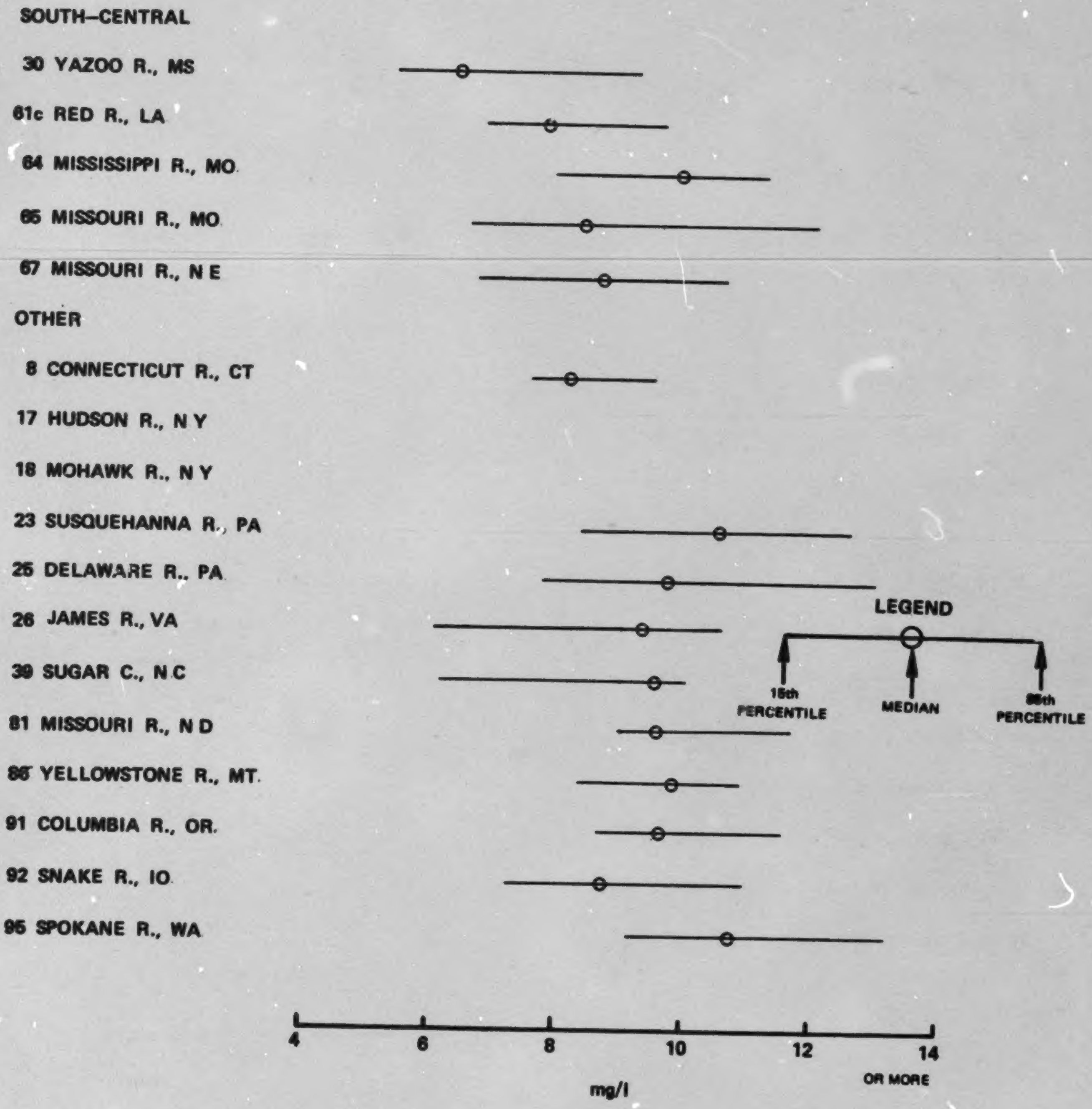


Figure A-18

CHEMICAL OXYGEN DEMAND
FOR
STATIONS ON LARGE STREAMS
1974

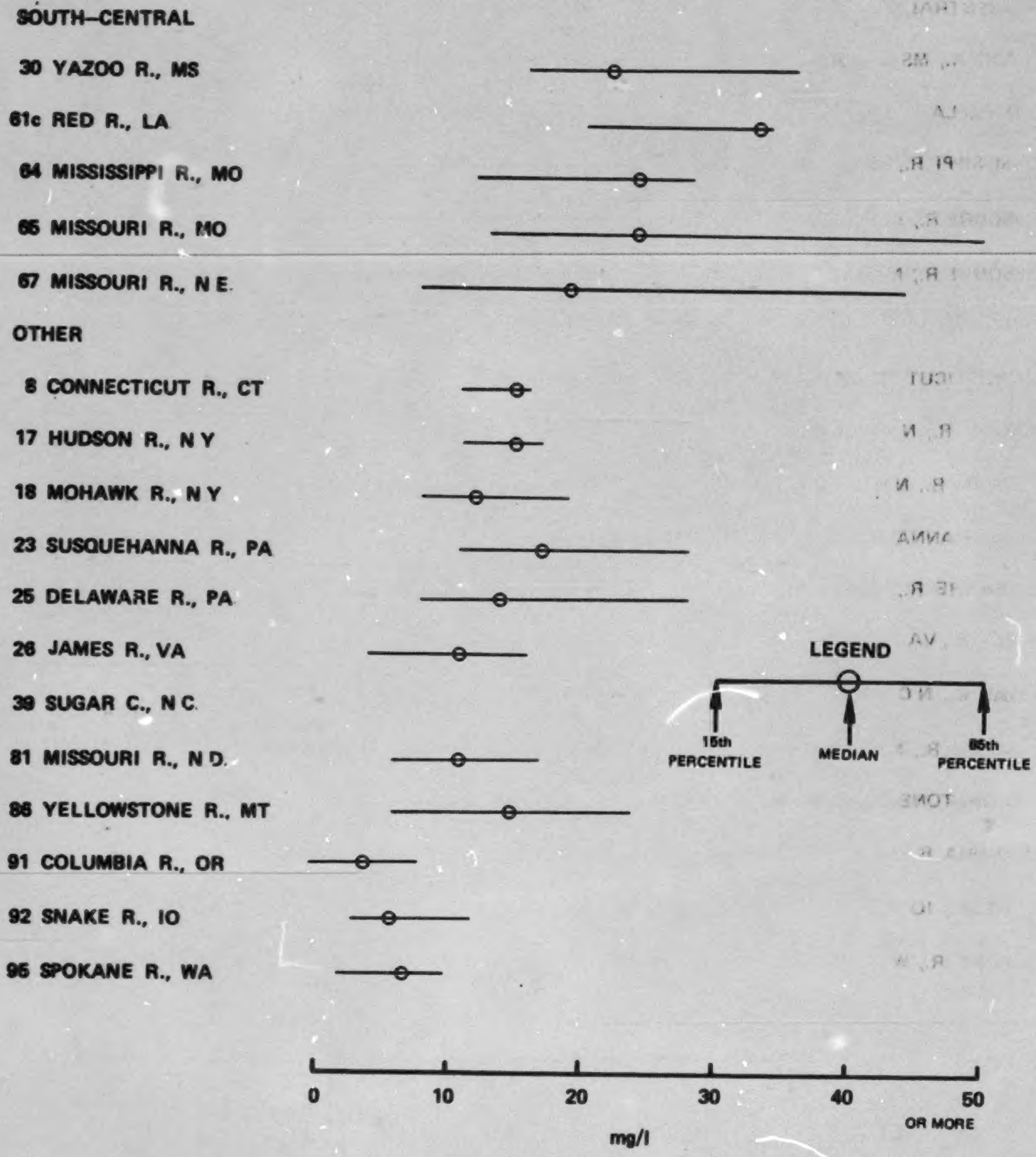
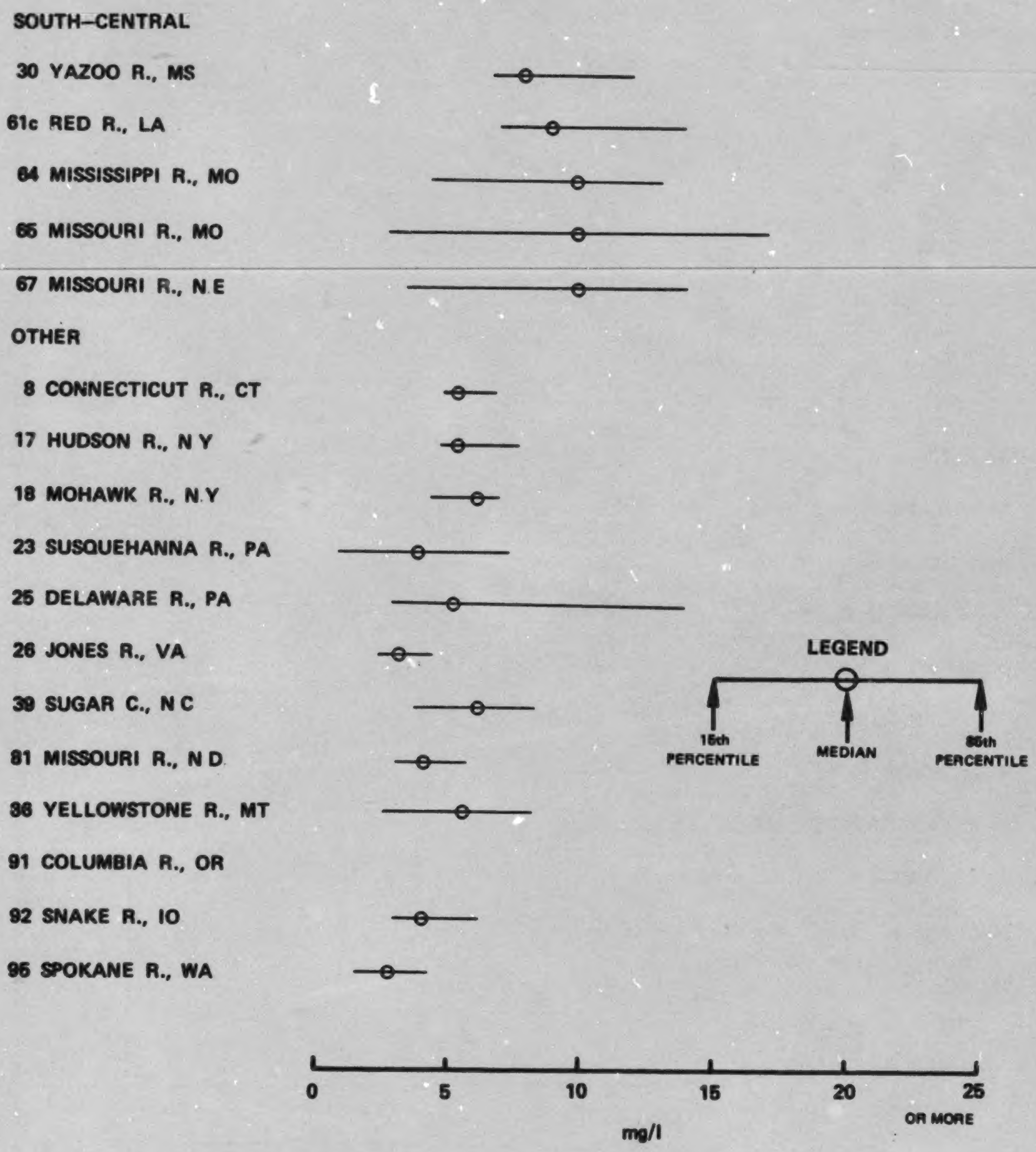


Figure A-19

TOTAL ORGANIC CARBON CONCENTRATIONS
FOR
STATIONS ON LARGE STREAMS
1974



## Figure A-20

# FECAL COLIFORM BACTERIA LEVELS
# FOR
# STATIONS ON LARGE STREAMS
# 1974

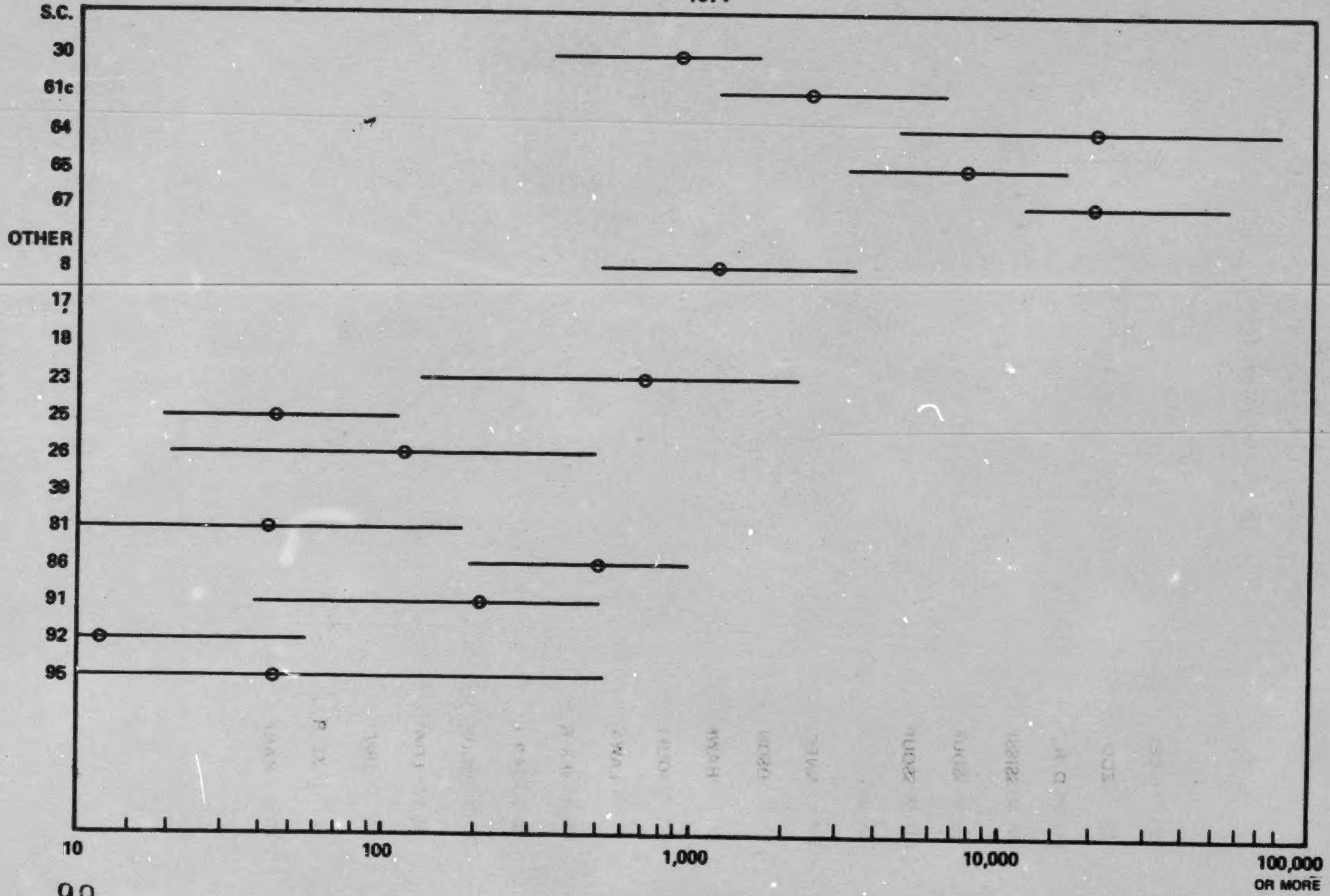


Figure A-21

CONDUCTIVITY LEVELS
FOR
STATIONS ON MEDIUM STREAMS
1974

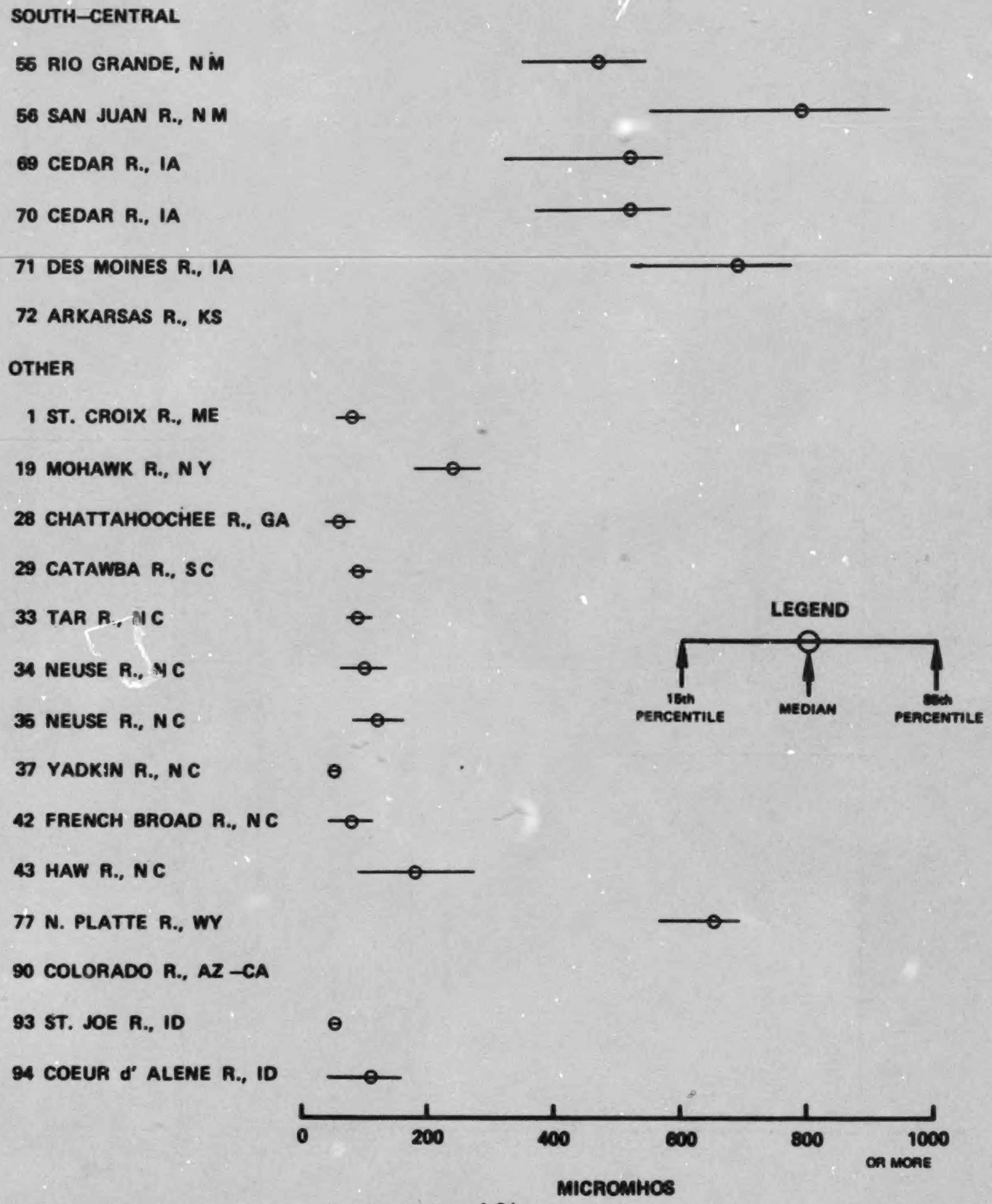


Figure A-22

TOTAL COPPER CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

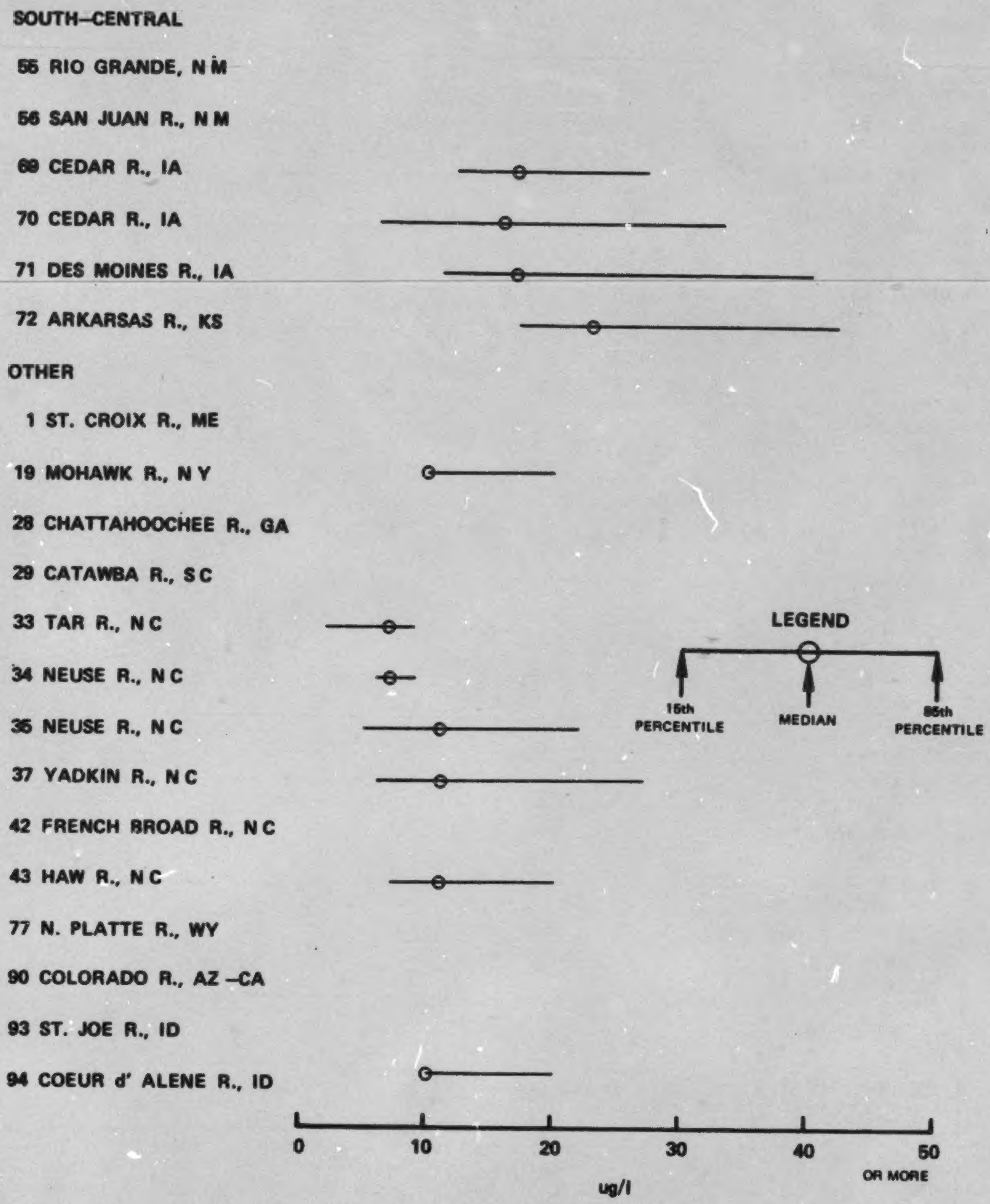


Figure A-23

TOTAL IRON CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

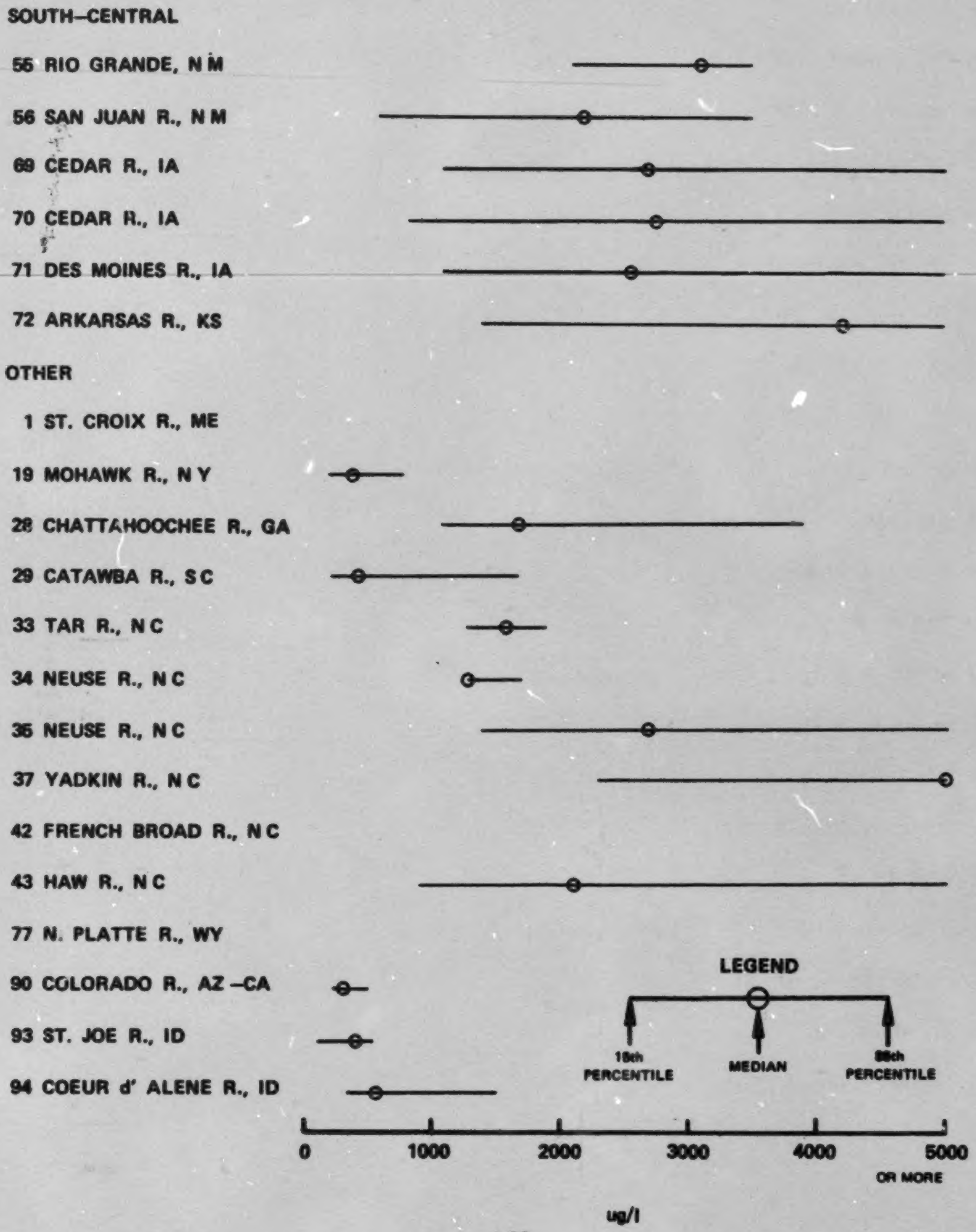


Figure A-24

## TOTAL LEAD CONCENTRATIONS FOR STATIONS ON MEDIUM STREAMS 1974

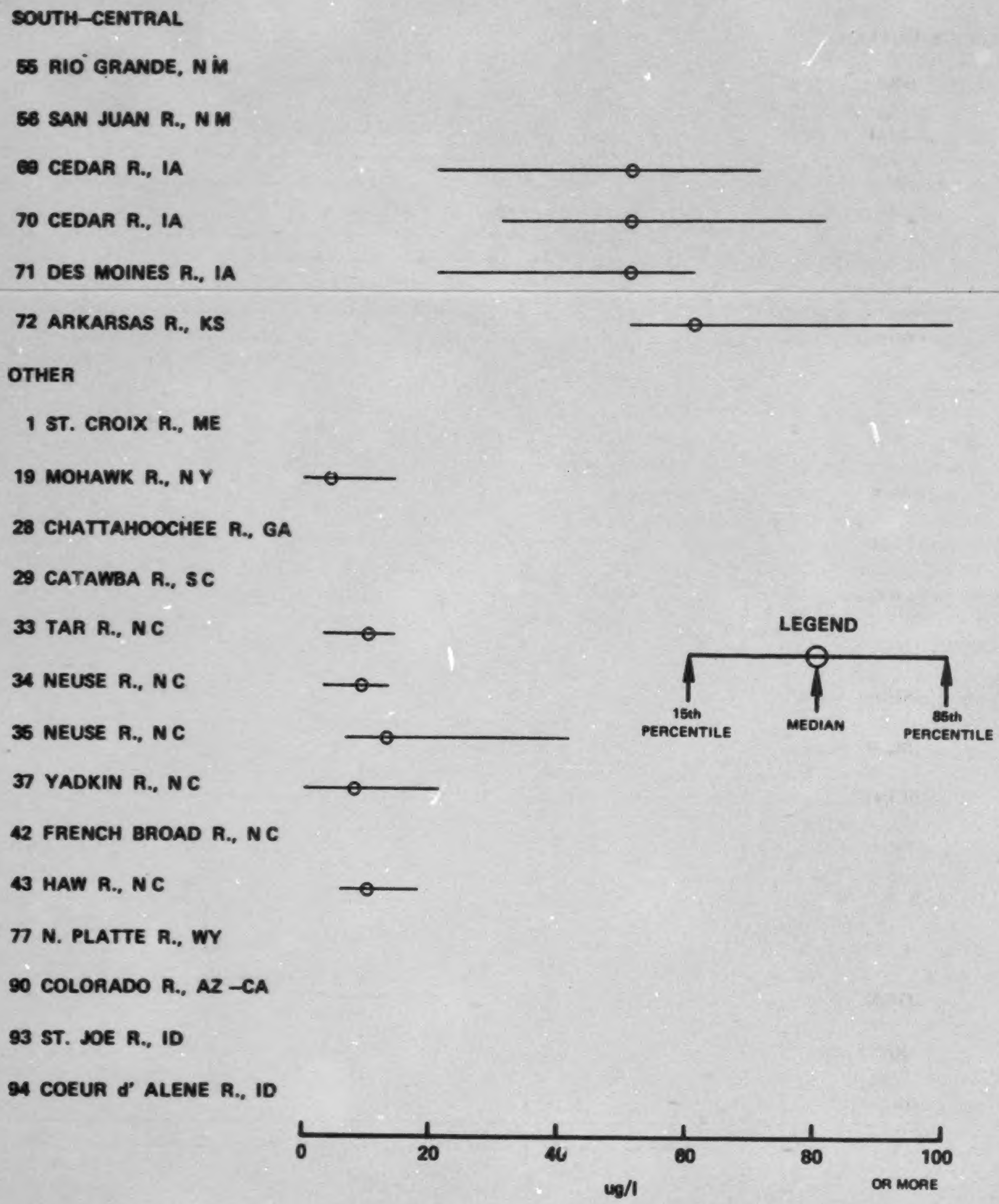


Figure A-25

## TOTAL MANGANESE CONCENTRATIONS FOR STATIONS ON MEDIUM STREAMS 1974

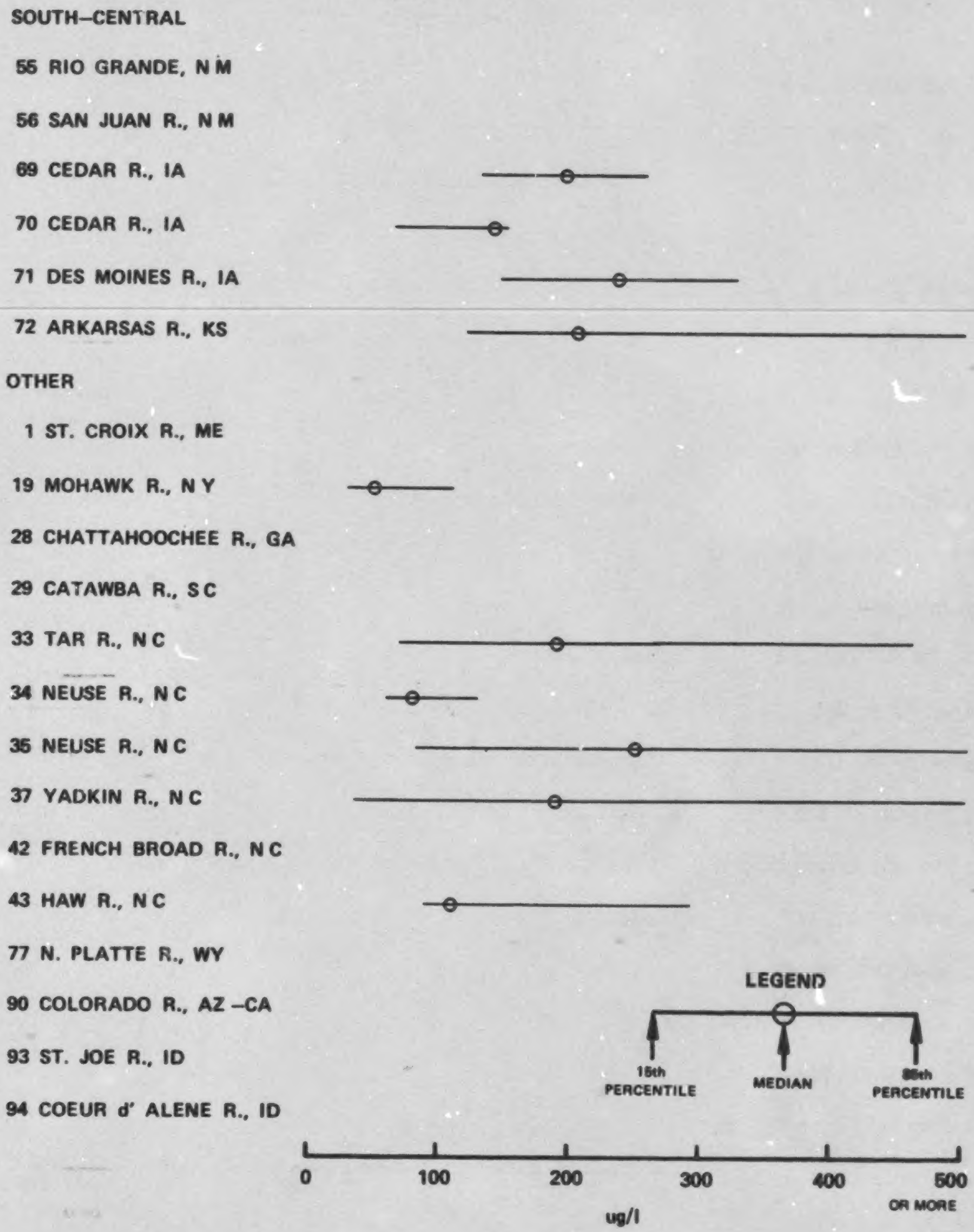


Figure A-26

## TOTAL ZINC CONCENTRATIONS
## FOR
## STATIONS ON MEDIUM STREAMS
## 1974

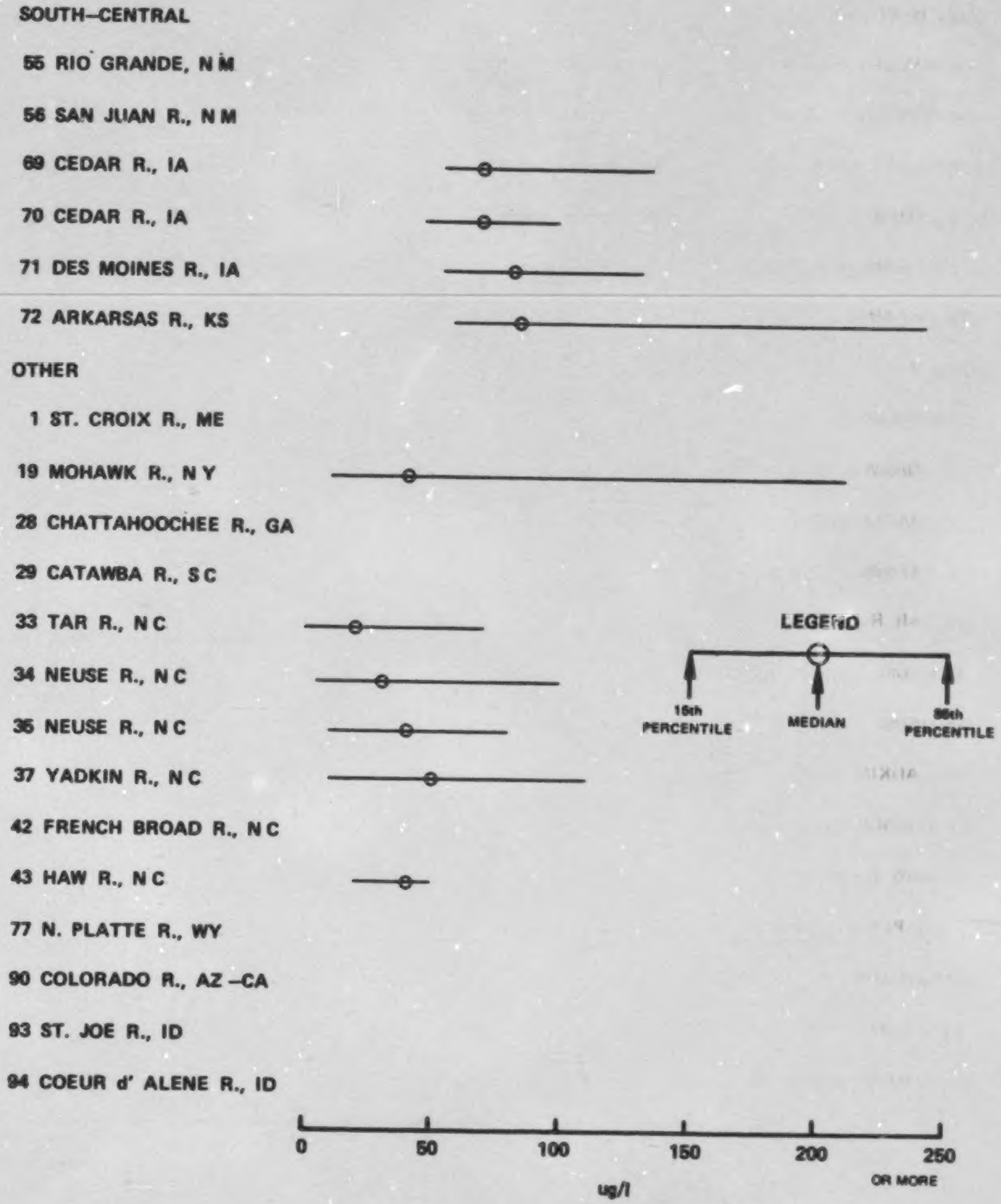


Figure A-27

### TURBIDITY LEVELS
### FOR
### STATIONS ON MEDIUM STREAMS
### 1974

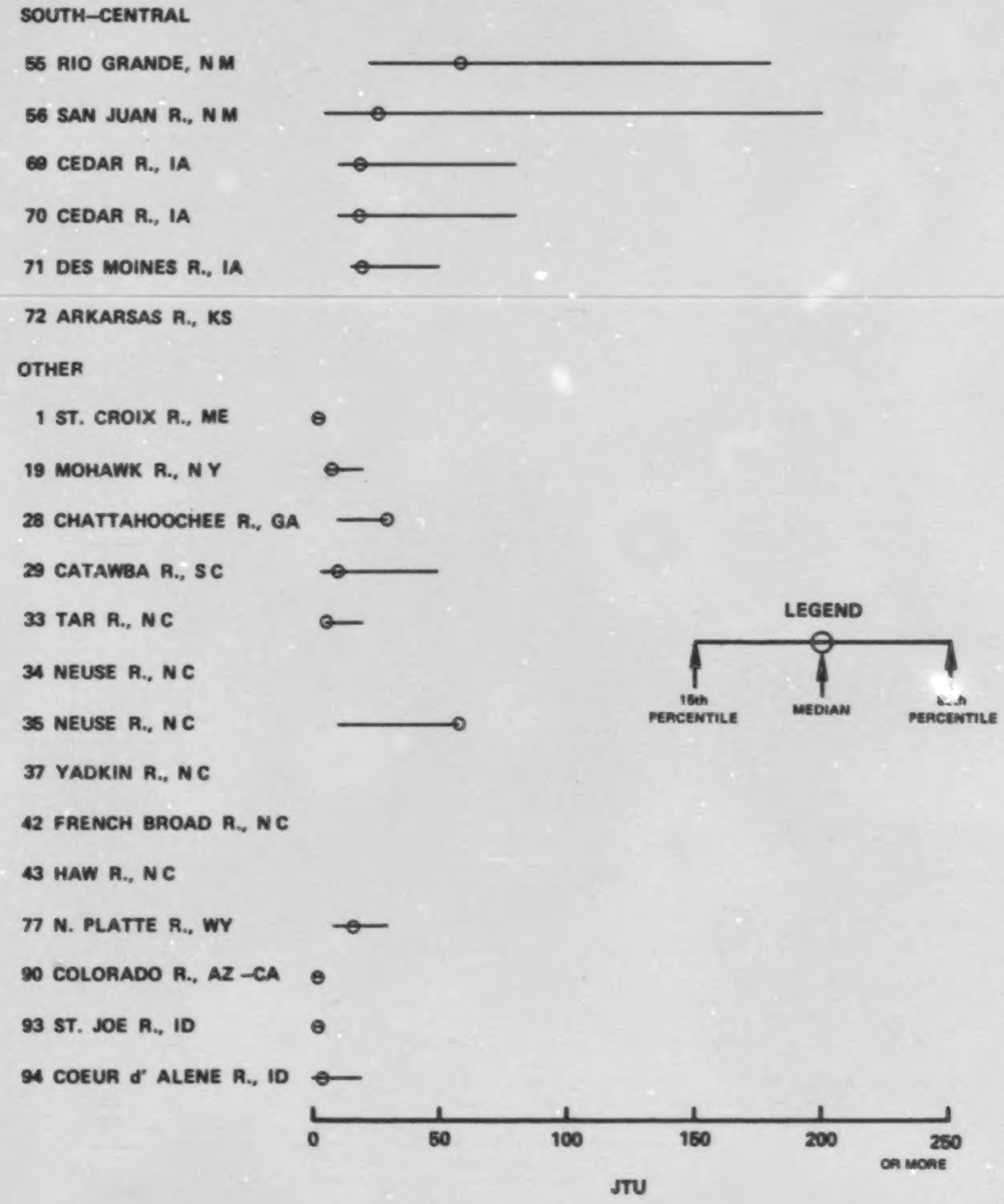


Figure A-28

### TOTAL SUSPENDED SOLID CONCENTRATIONS
### FOR
### STATIONS ON MEDIUM STREAMS
### 1974

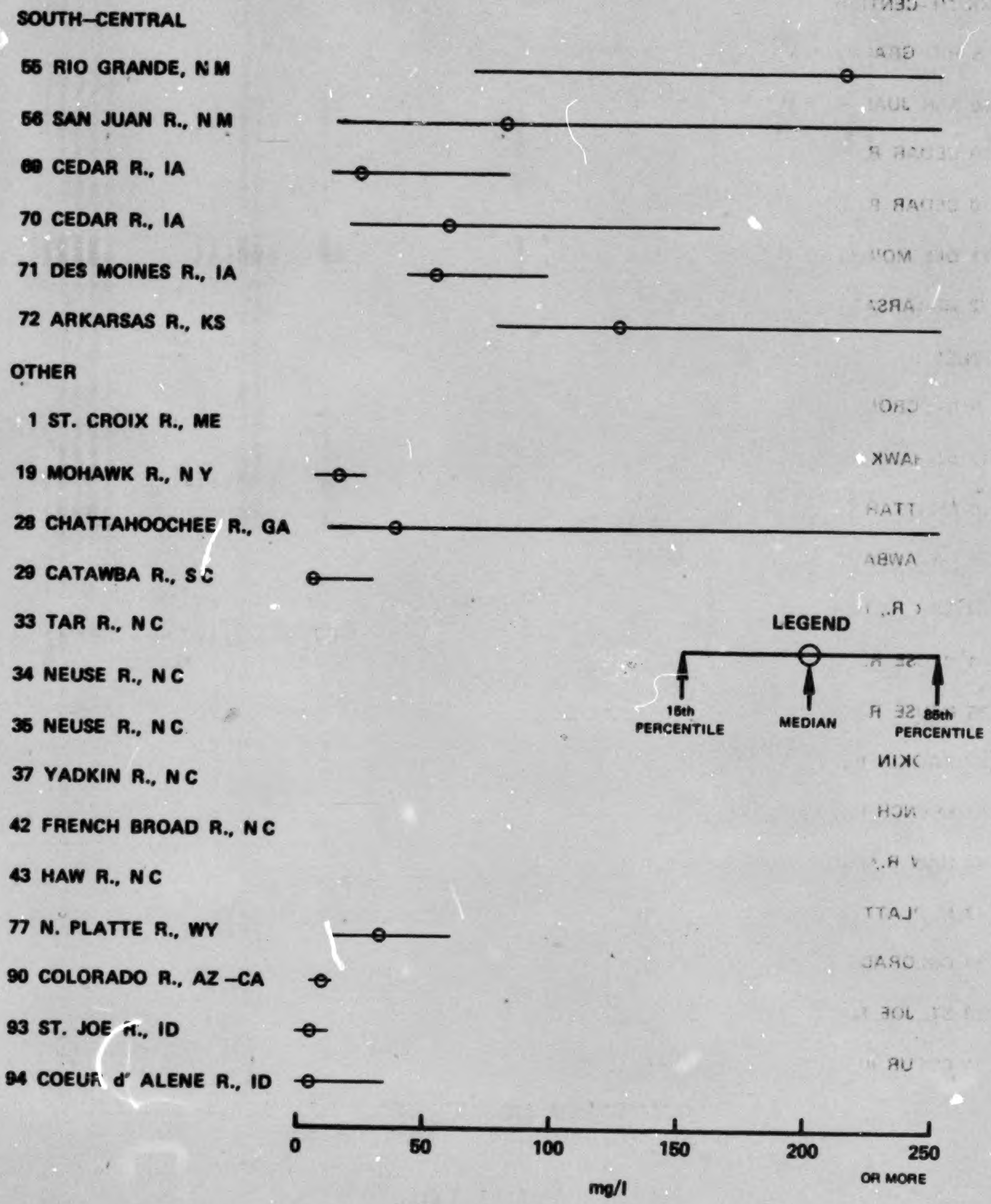


Figure A-29

TOTAL DISSOLVED SOLID CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

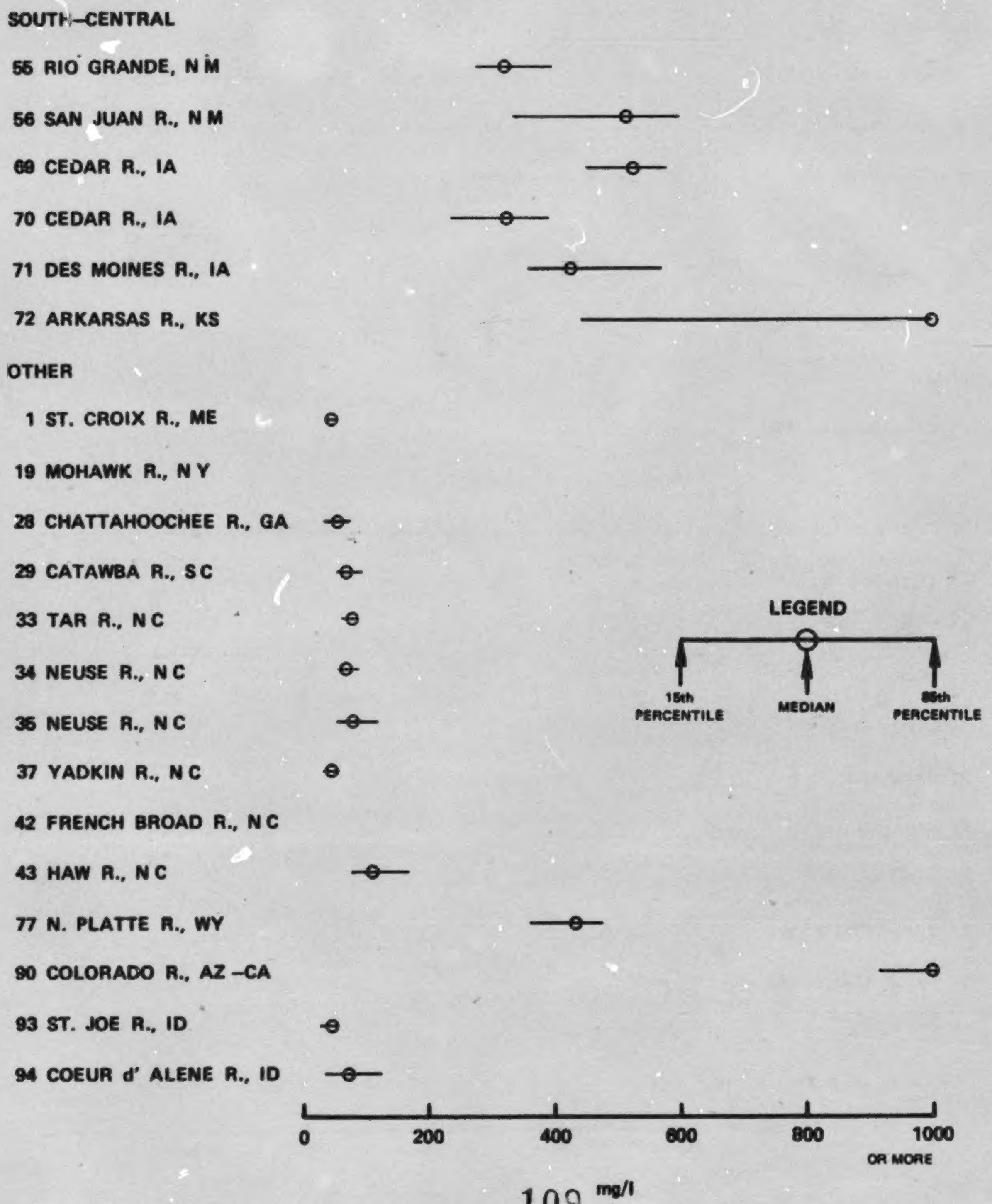


Figure A-30

CHLORIDE CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

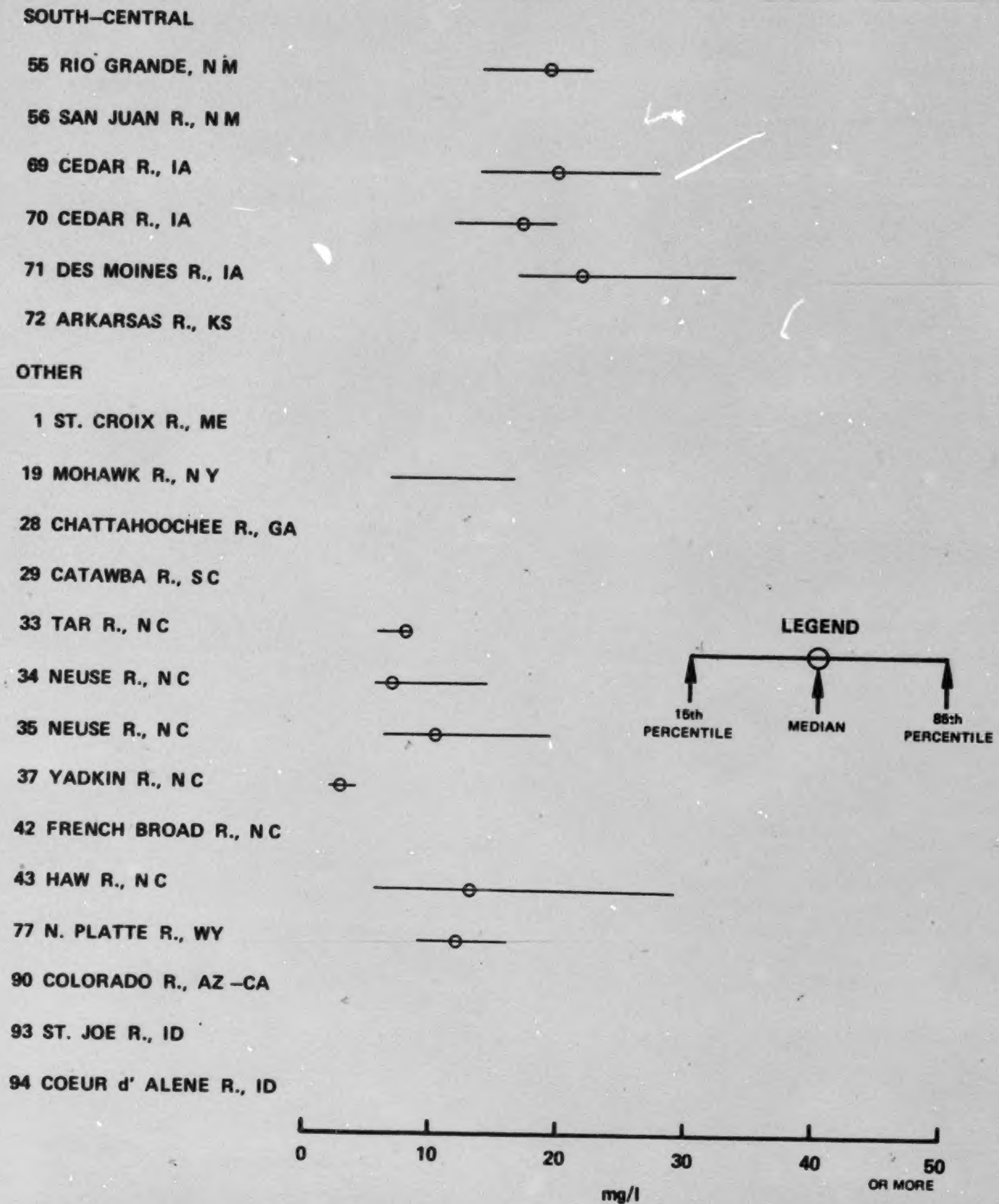


Figure A-31

TOTAL SULFATE CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

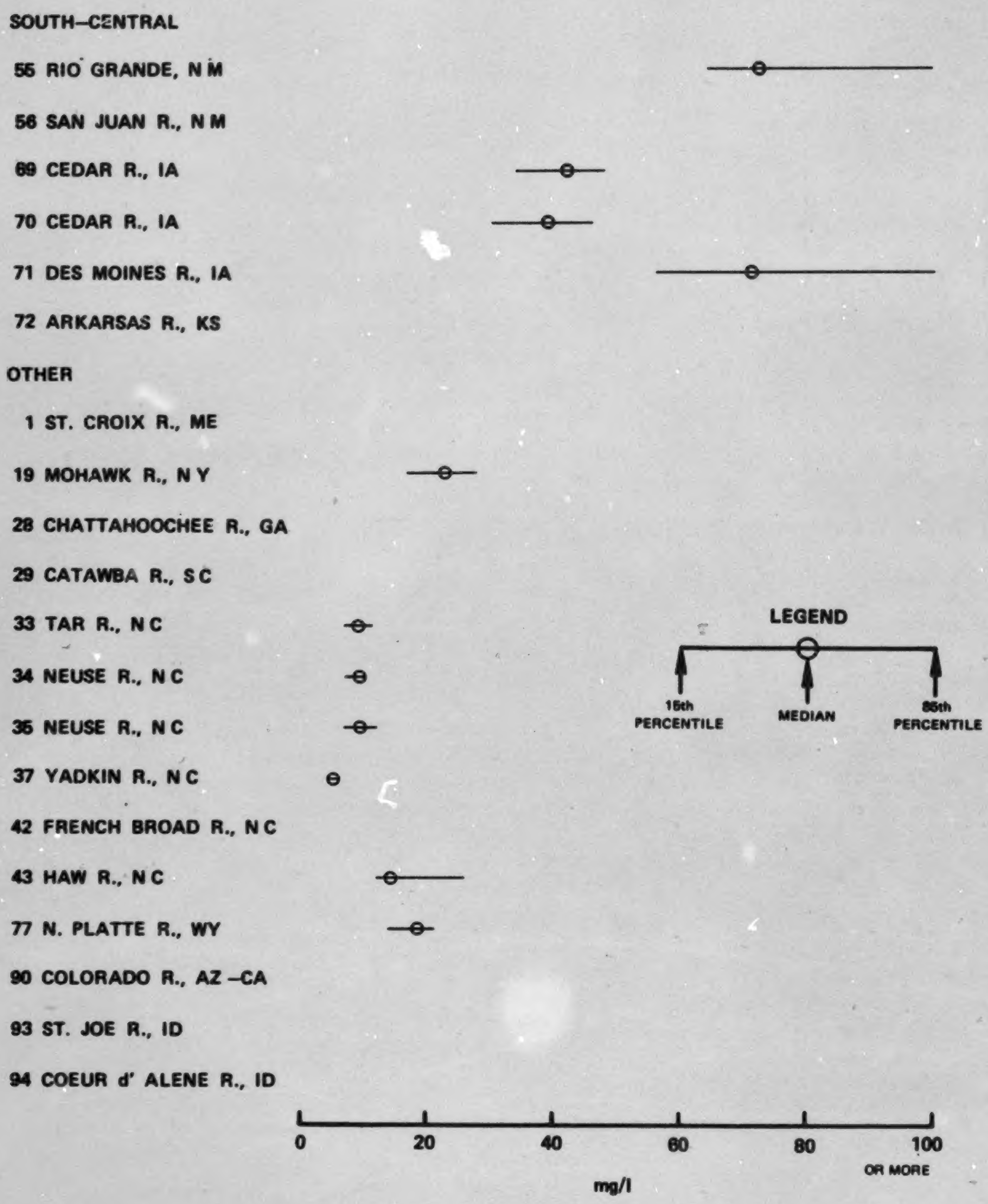


Figure A-32

TOTAL AMMONIA CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

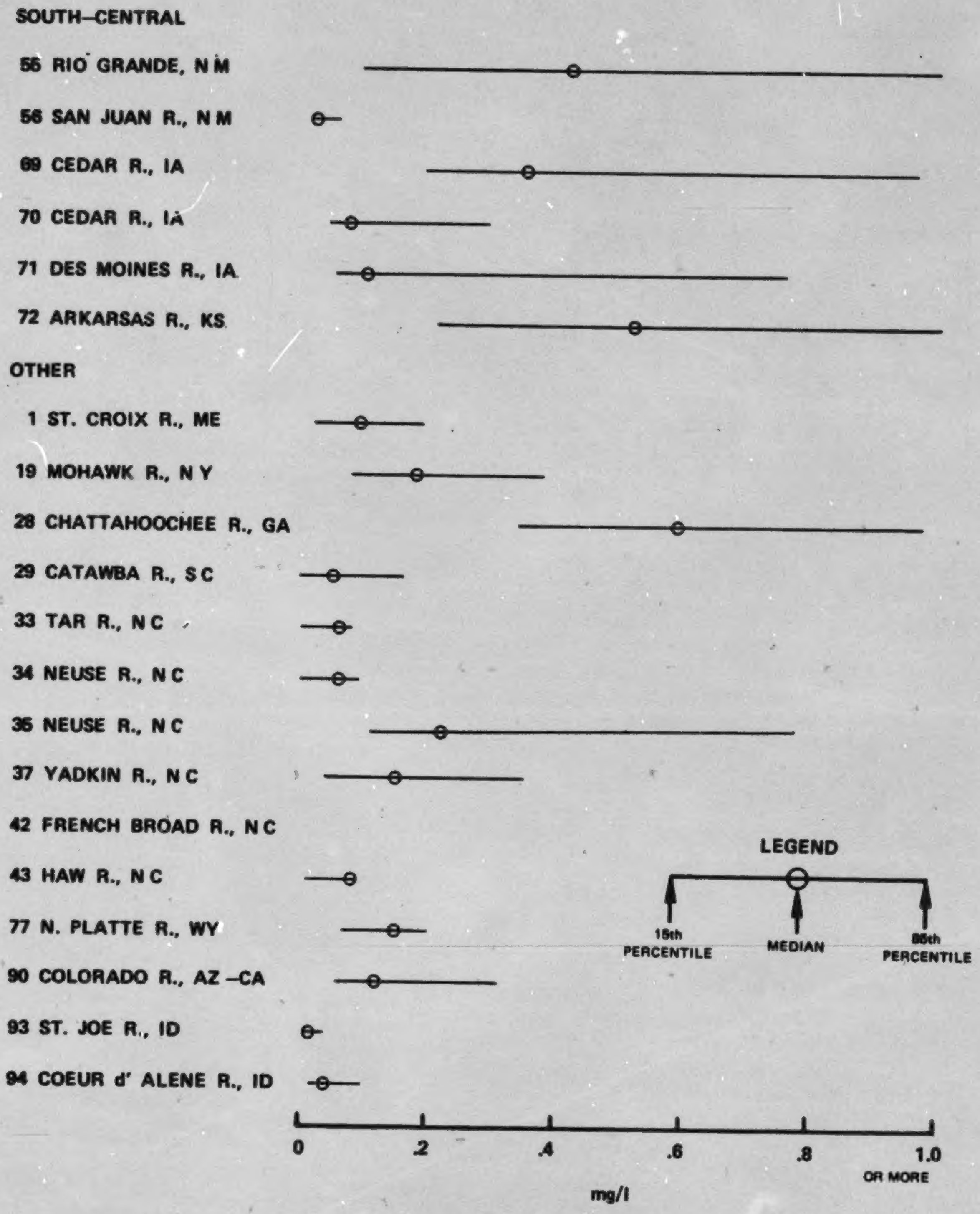


Figure A-33

TOTAL KJELDAHL NITROGEN CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

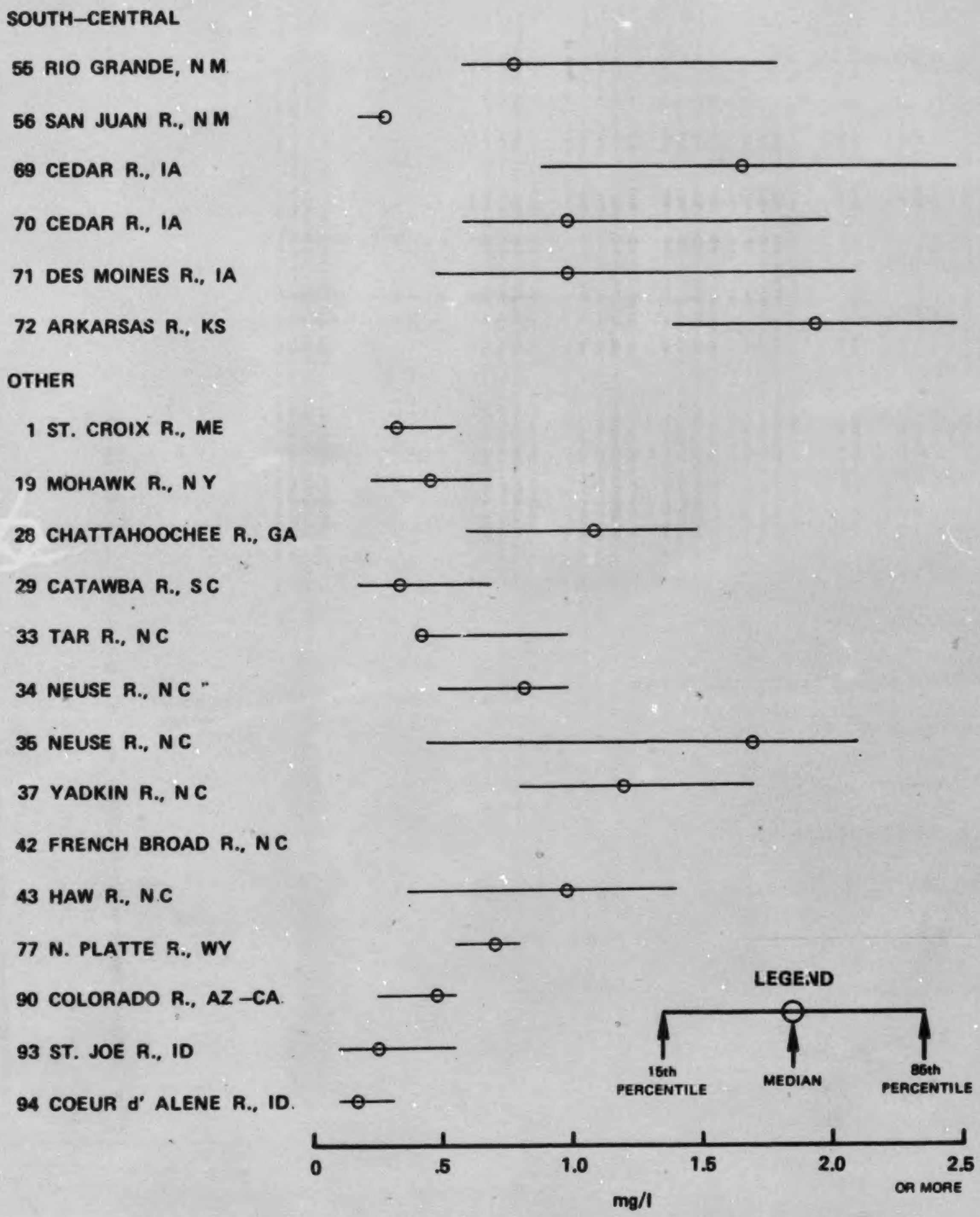


Figure A-34

TOTAL NITRATE PLUS NITRITE CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

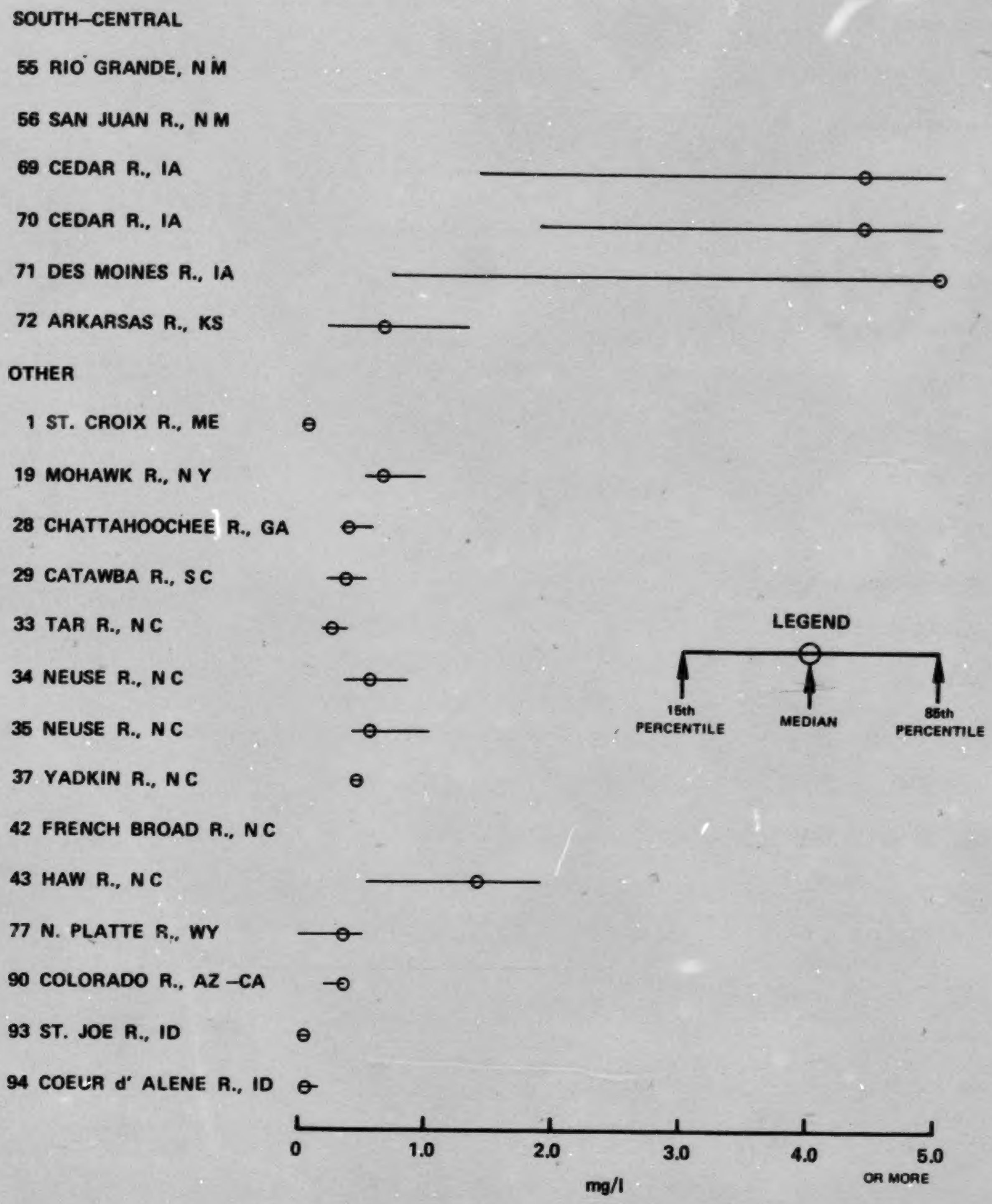


Figure A-35

TOTAL PHOSPHORUS CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

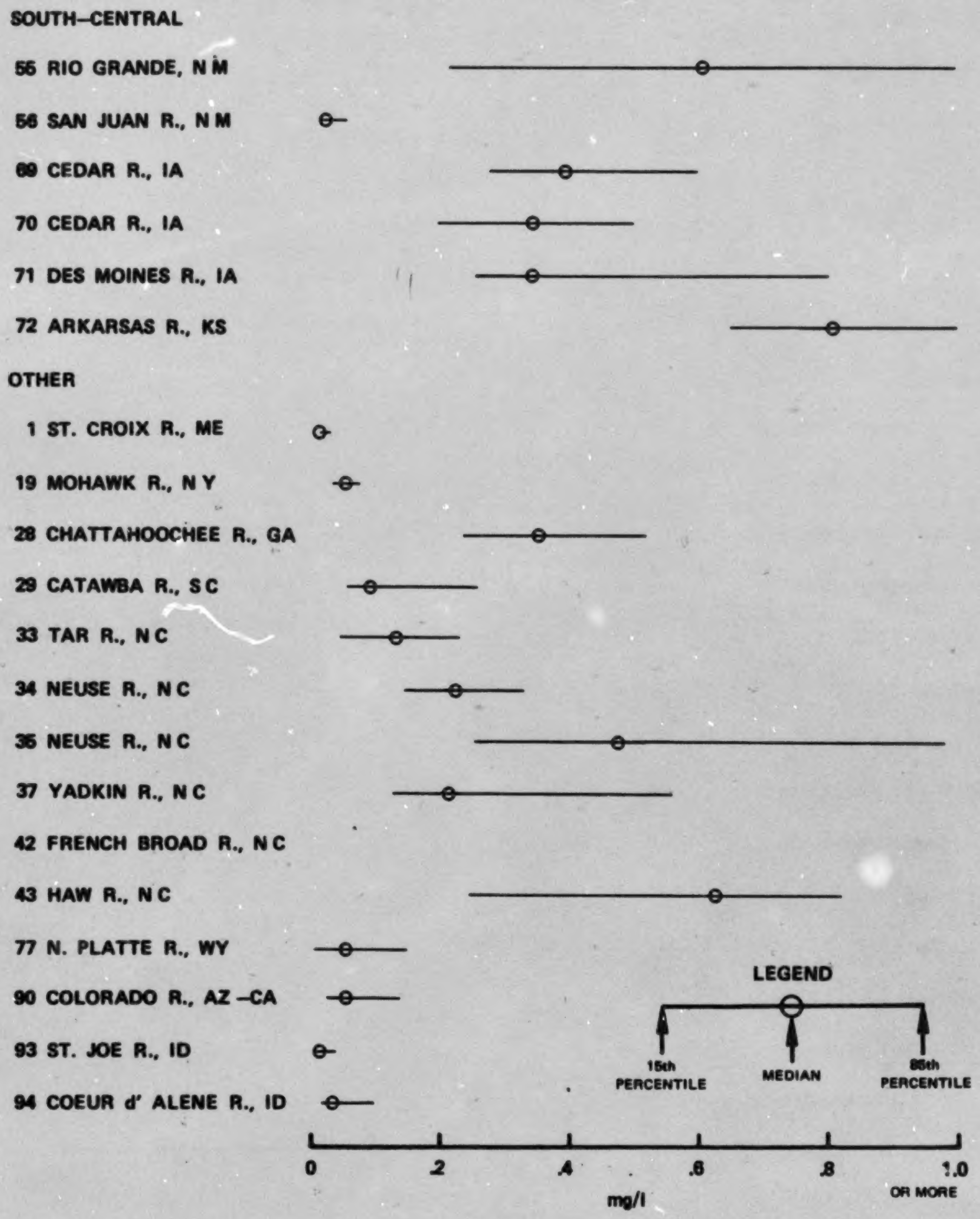


Figure A-36

DISSOLVED OXYGEN CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

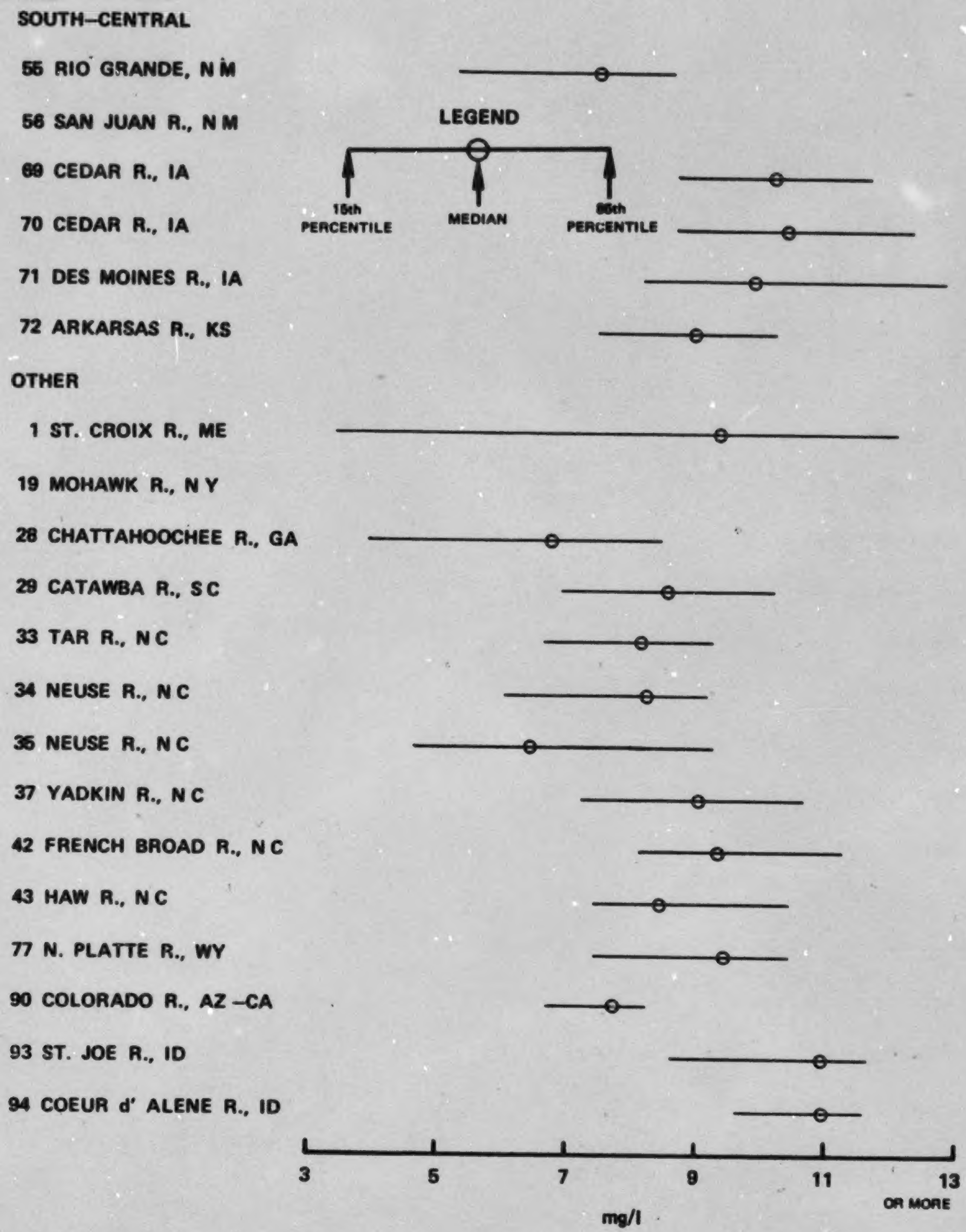


Figure A-37

## CHEMICAL OXYGEN DEMAND
## FOR
## STATIONS ON MEDIUM STREAMS
## 1974

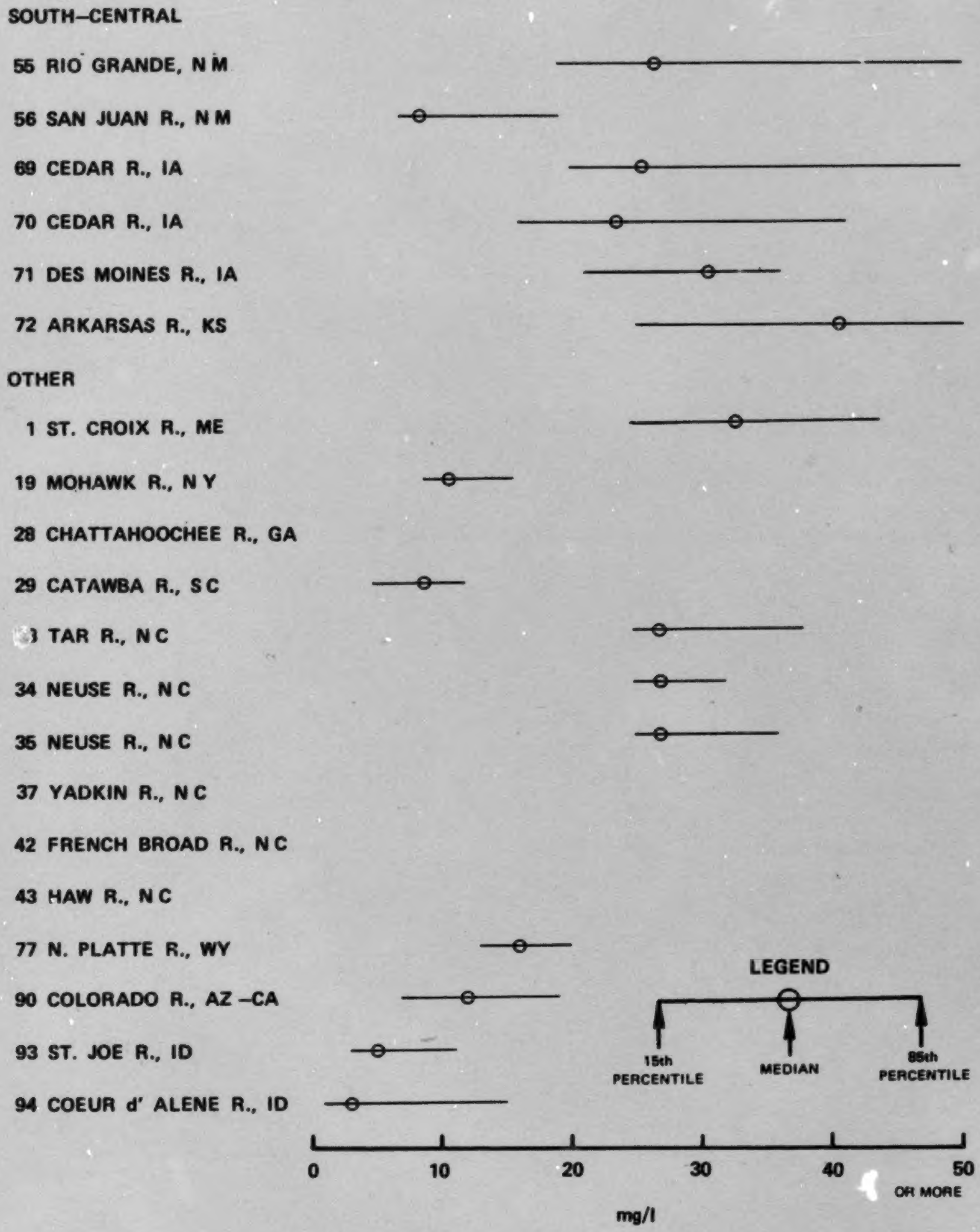


Figure A-38

TOTAL ORGANIC CARBON CONCENTRATIONS
FOR
STATIONS ON MEDIUM STREAMS
1974

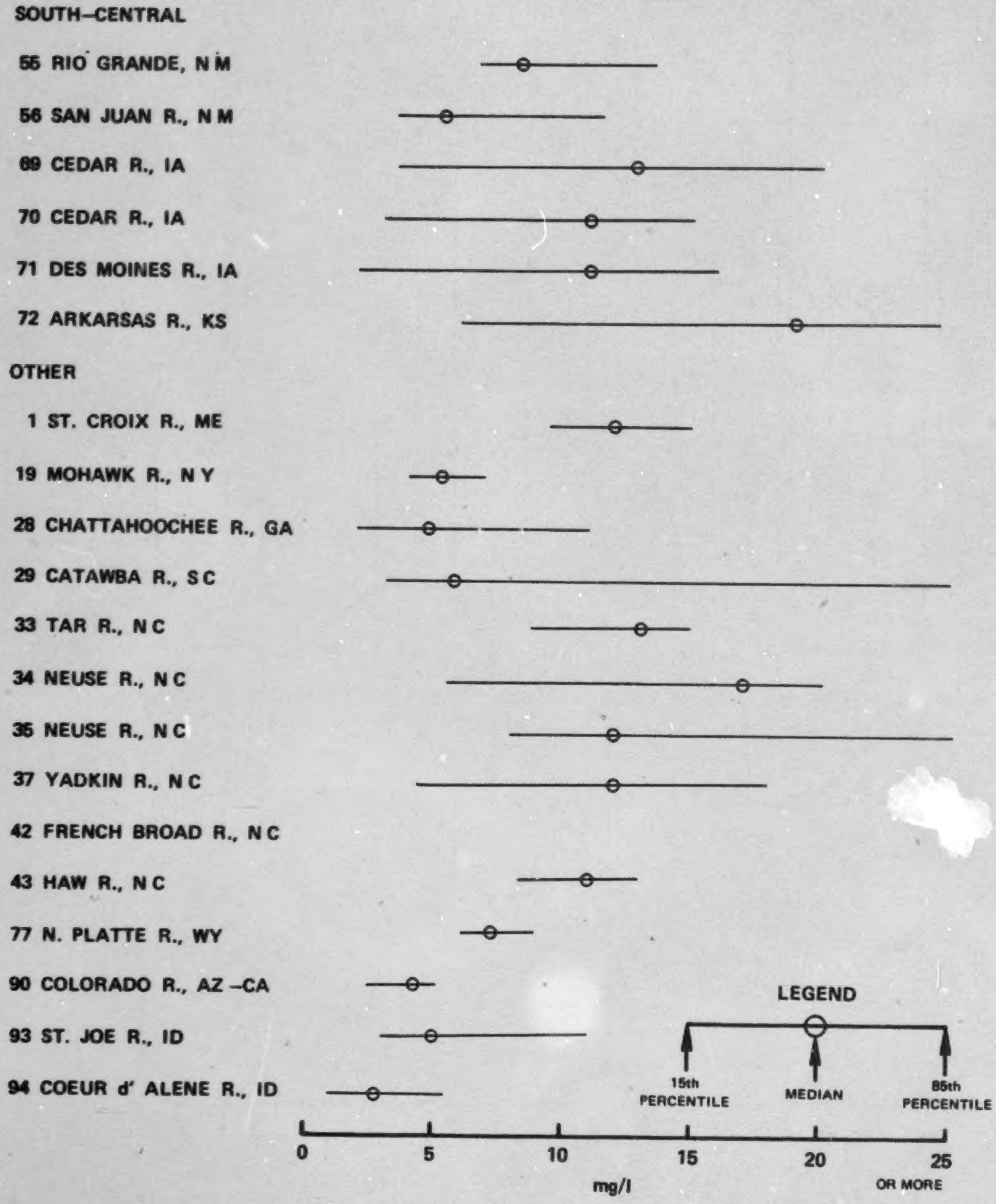


Figure A-39

FECAL COLIFORM BACTERIA LEVELS
FOR
STATIONS ON MEDIUM STREAMS
1974

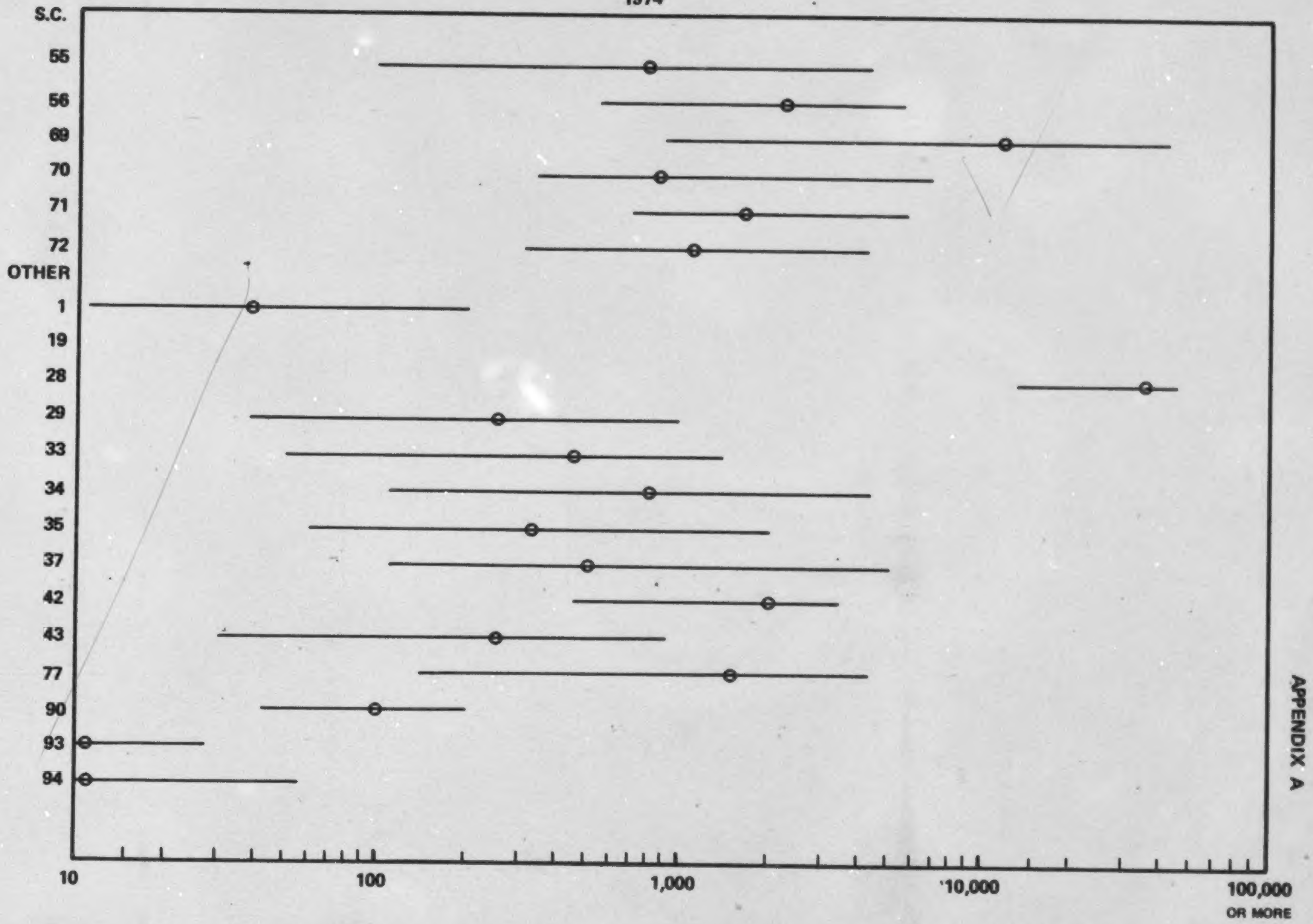


Figure A-40

CONDUCTIVITY LEVELS
FOR
STATIONS ON SMALL STREAMS
1974

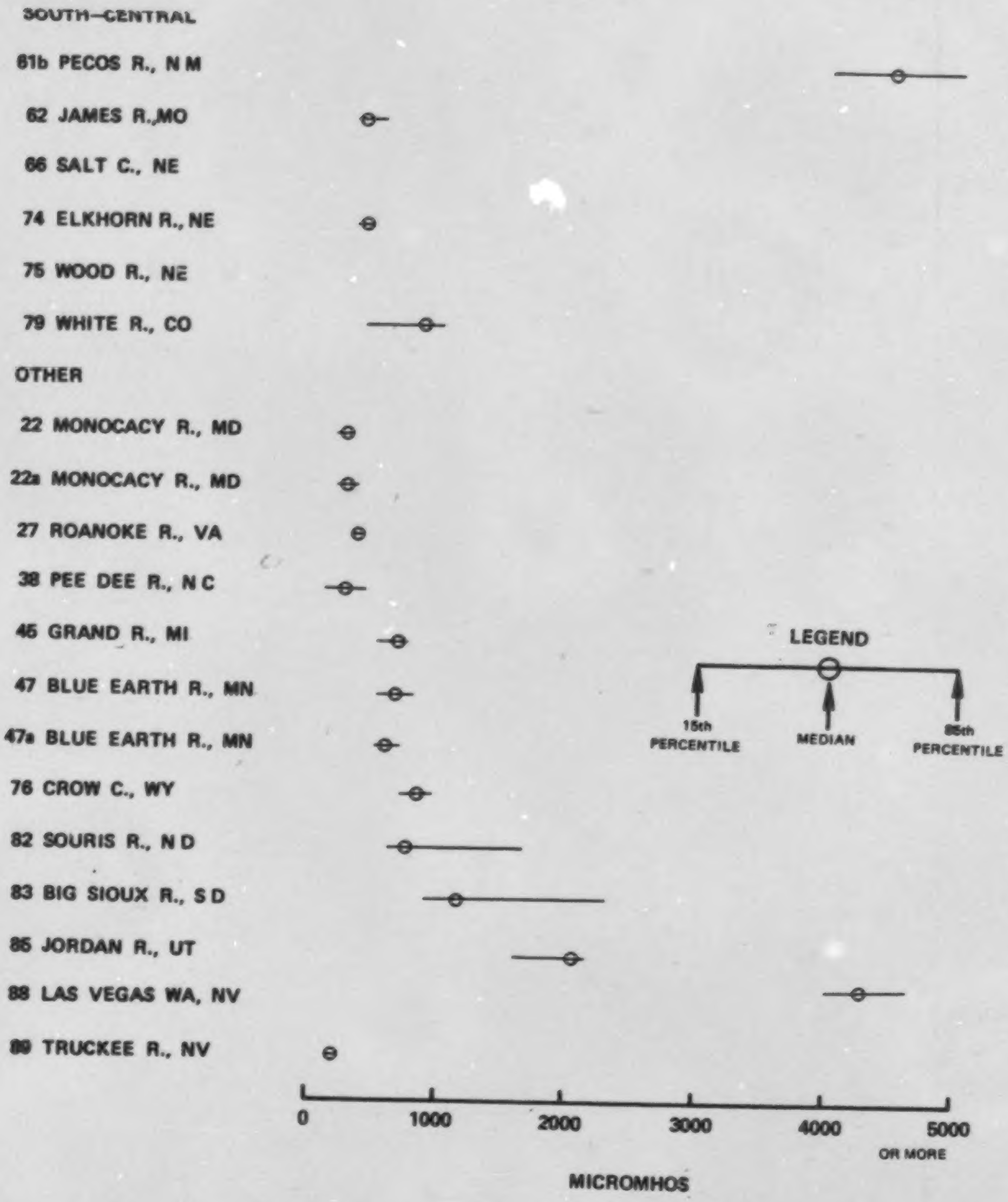


Figure A-41

TOTAL COPPER CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

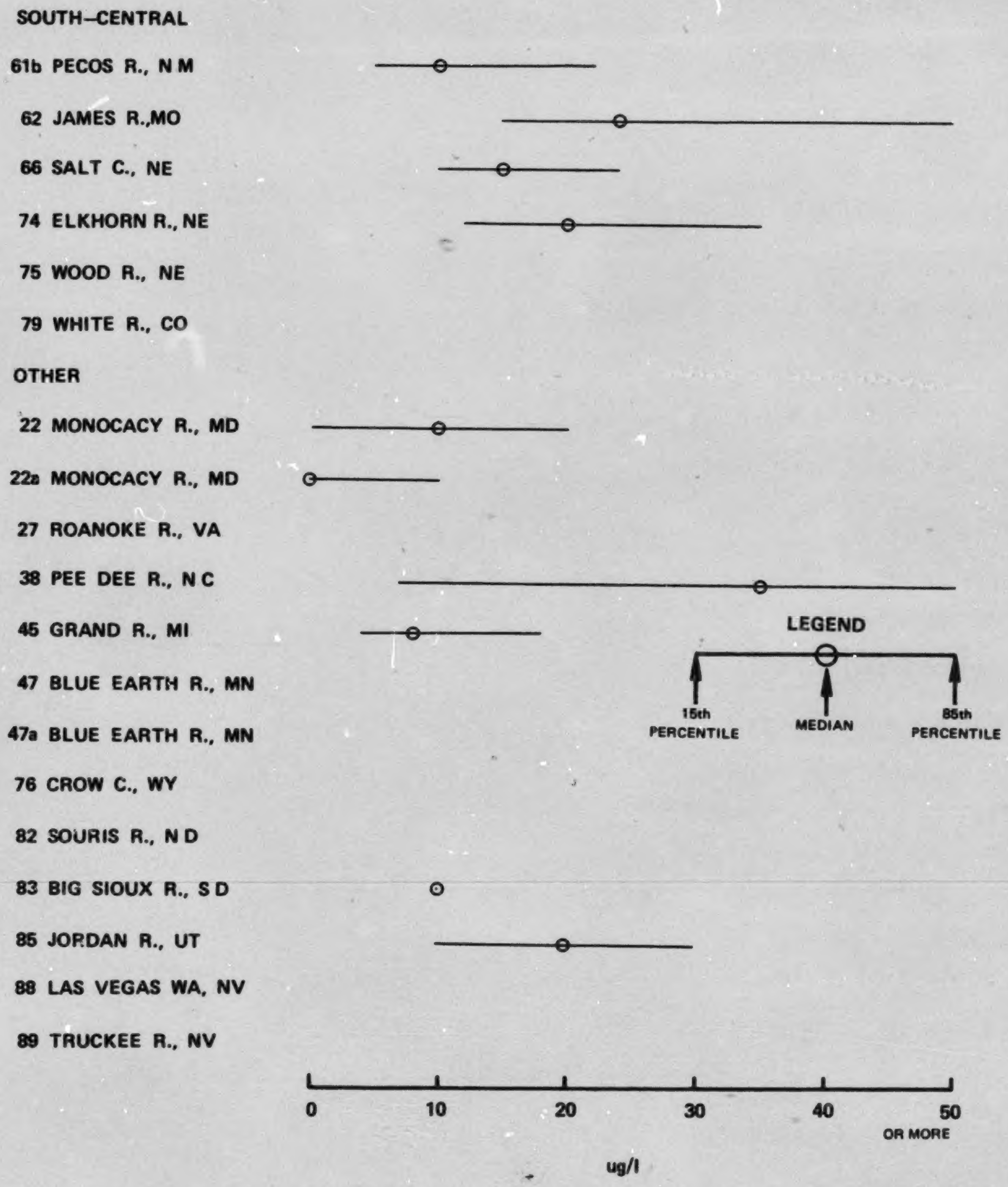


Figure A-42

TOTAL IRON CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

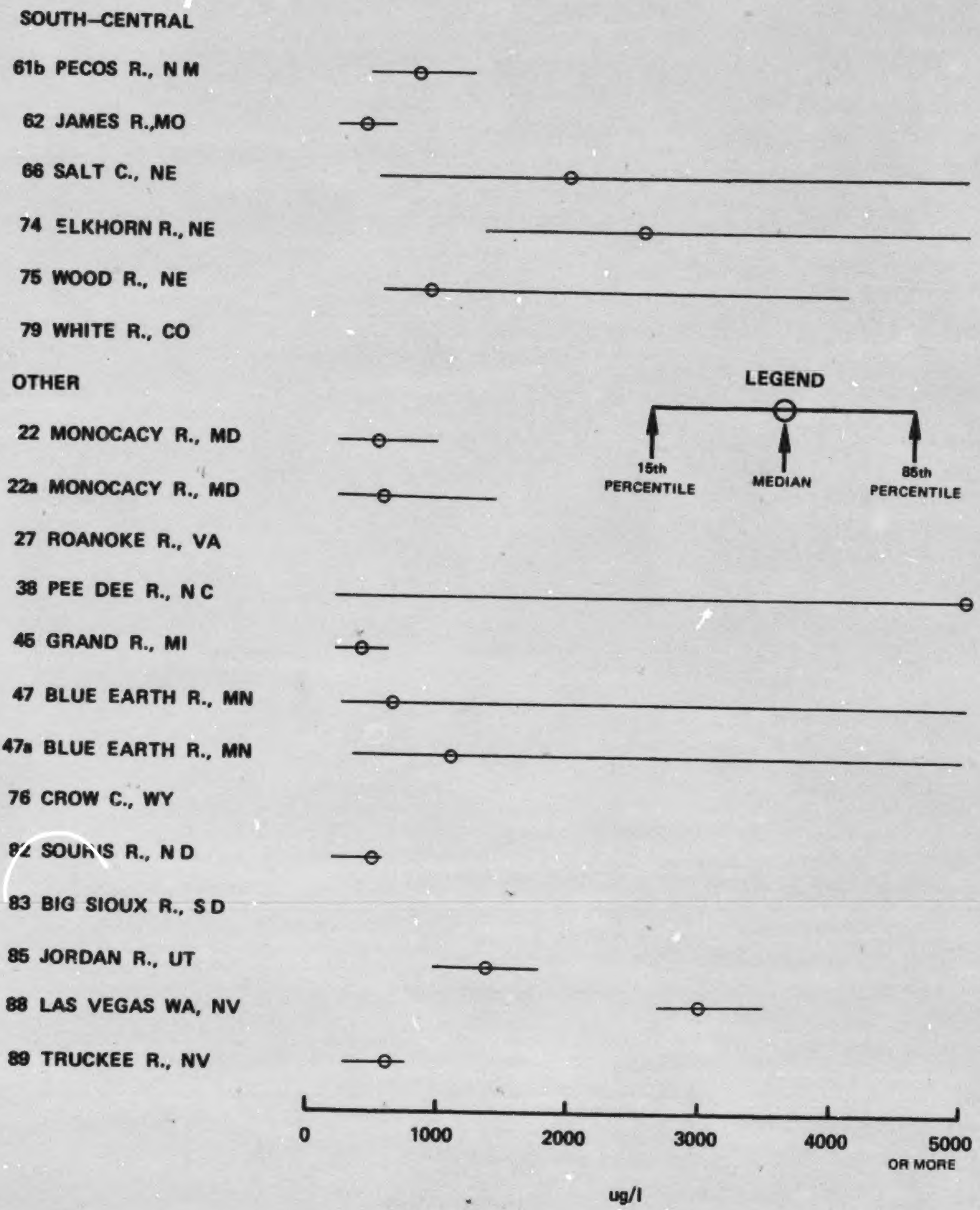


Figure A-43

TOTAL LEAD CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

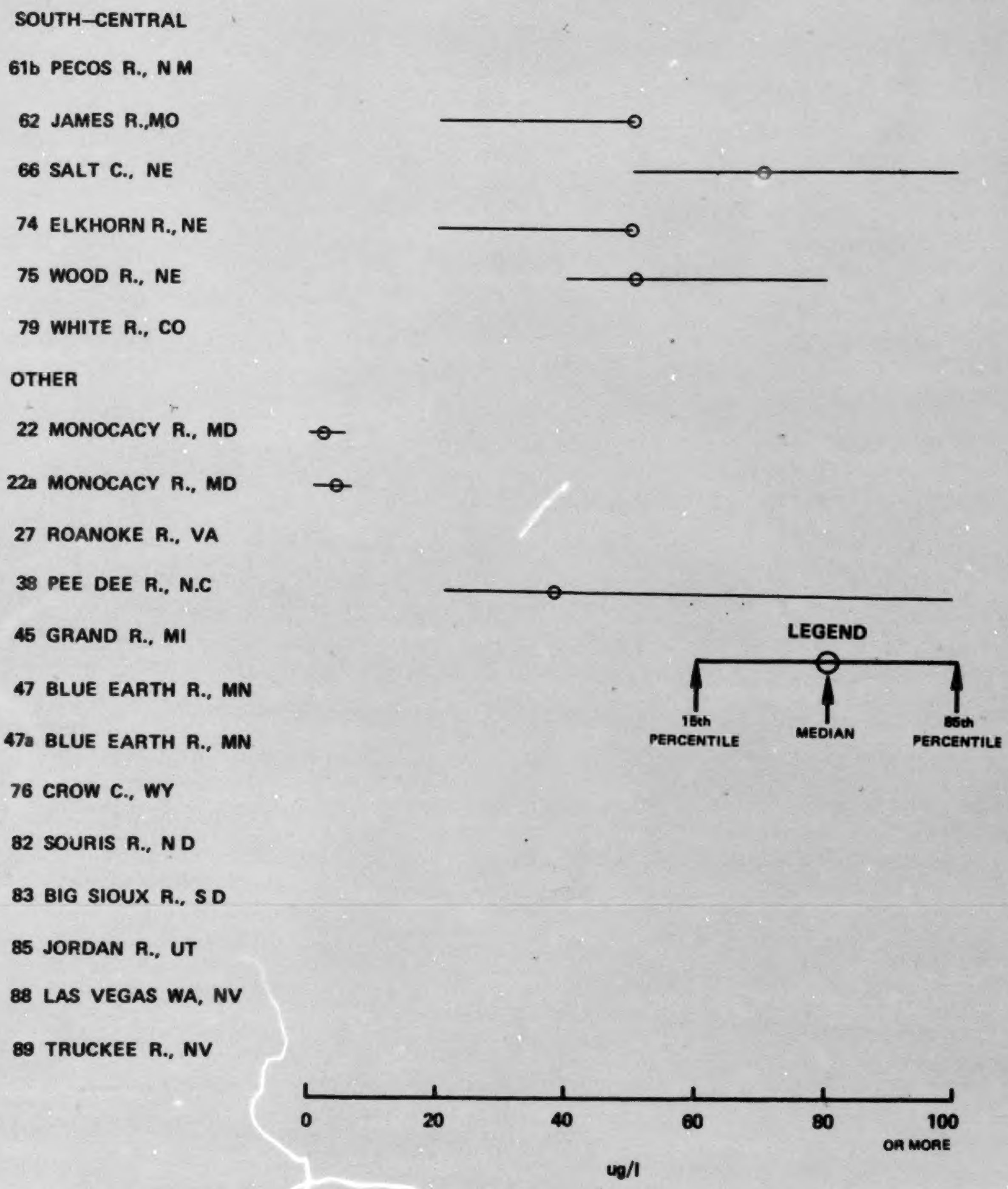


Figure A-44
TOTAL MAGANESE CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

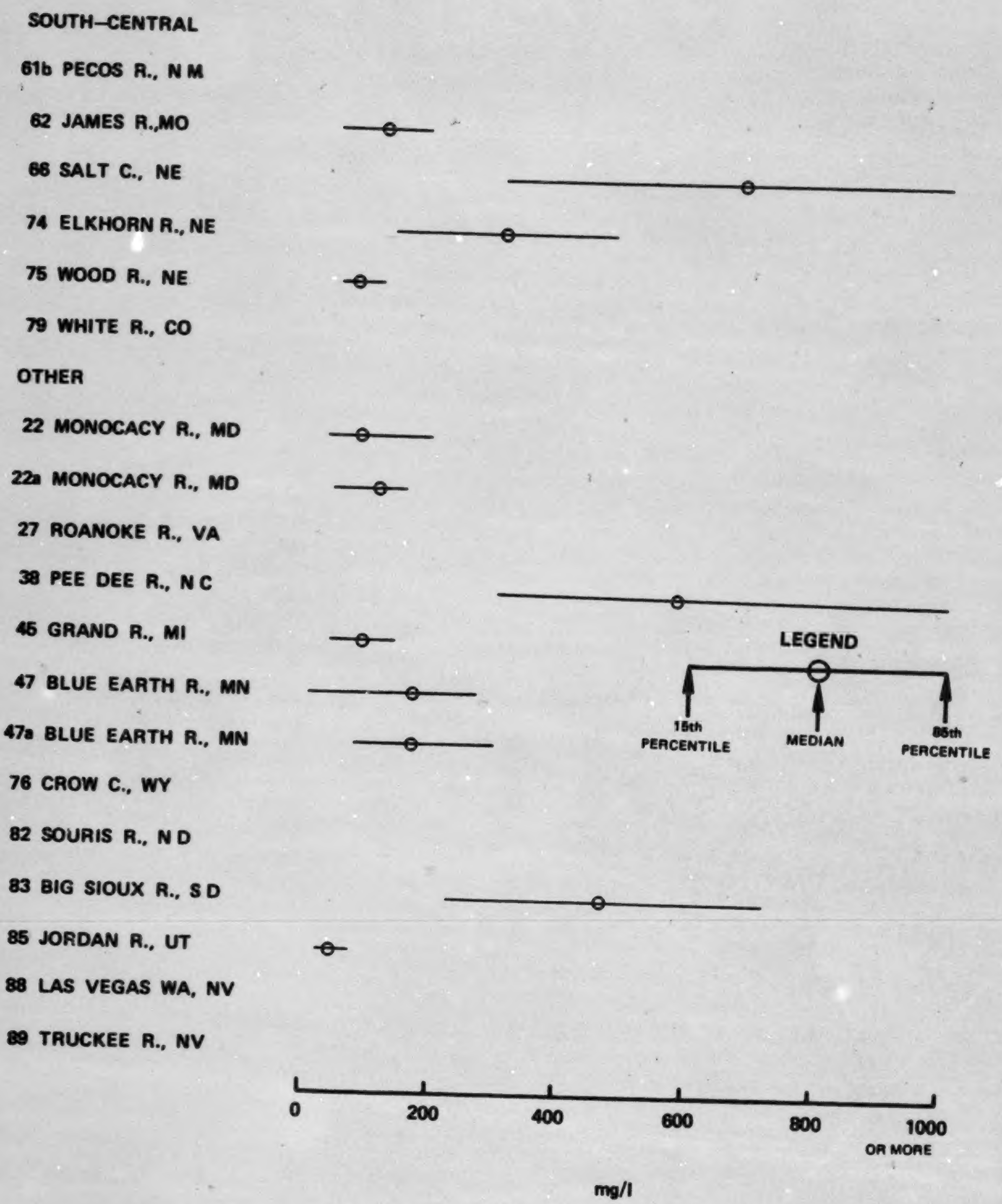


Figure A-45

## TOTAL ZINC CONCENTRATIONS
## FOR
## STATIONS ON SMALL STREAMS
## 1974

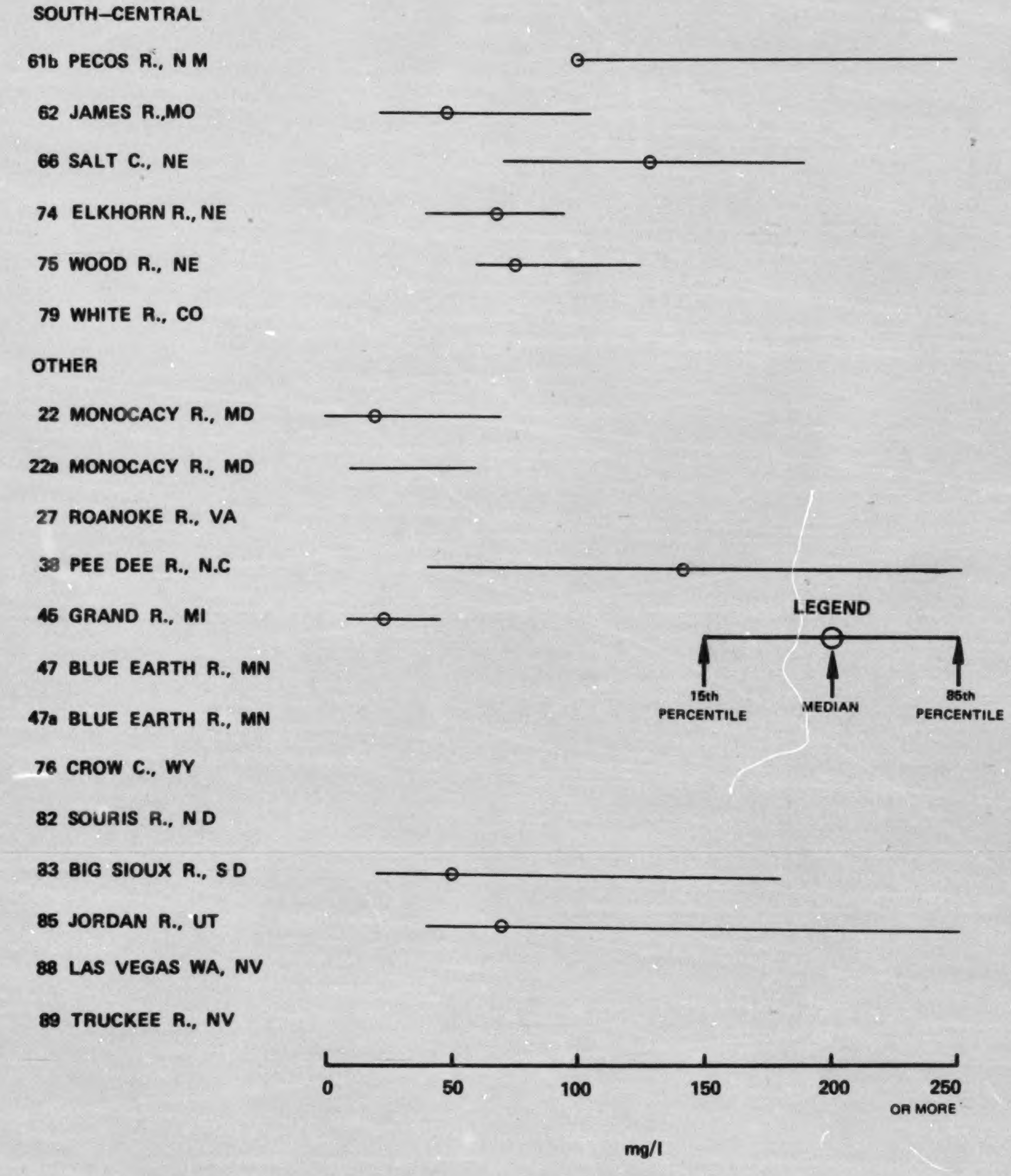


Figure A-46

TURBIDITY LEVELS
FOR
STATIONS ON SMALL STREAMS
1974

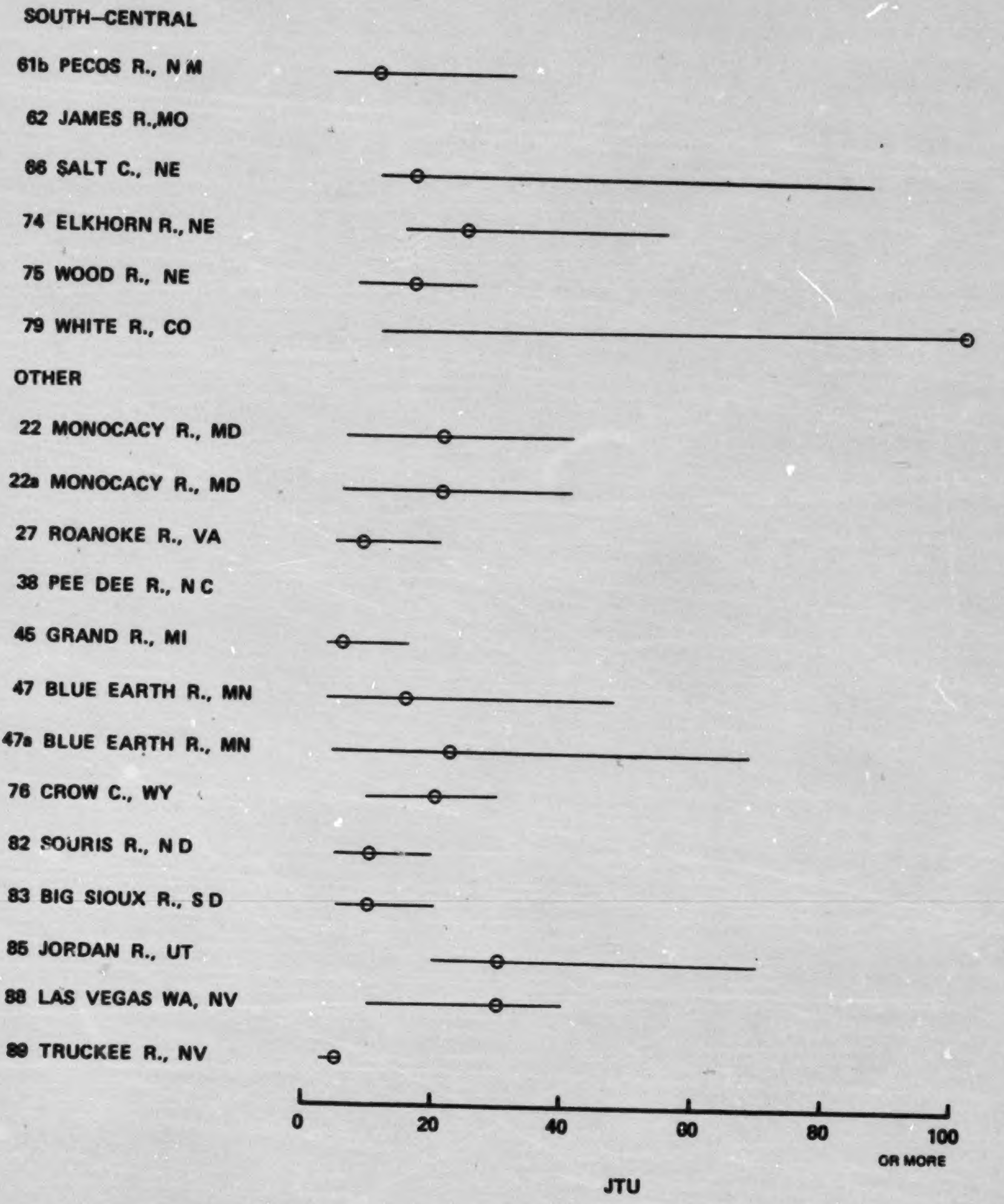


Figure A-47

TOTAL SUSPENDED SOLID CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

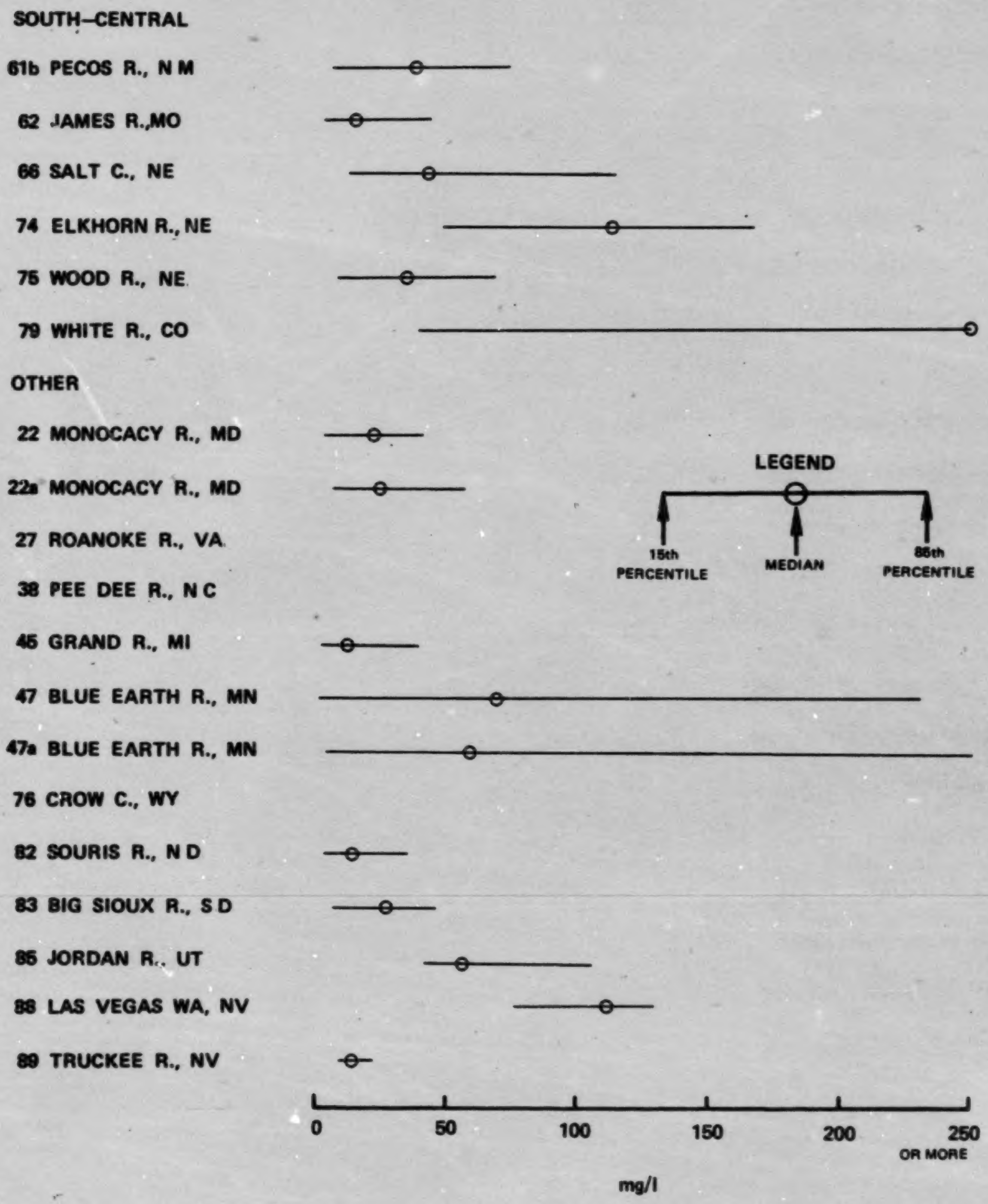


Figure A-48

TOTAL DISSOLVED SOLID CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
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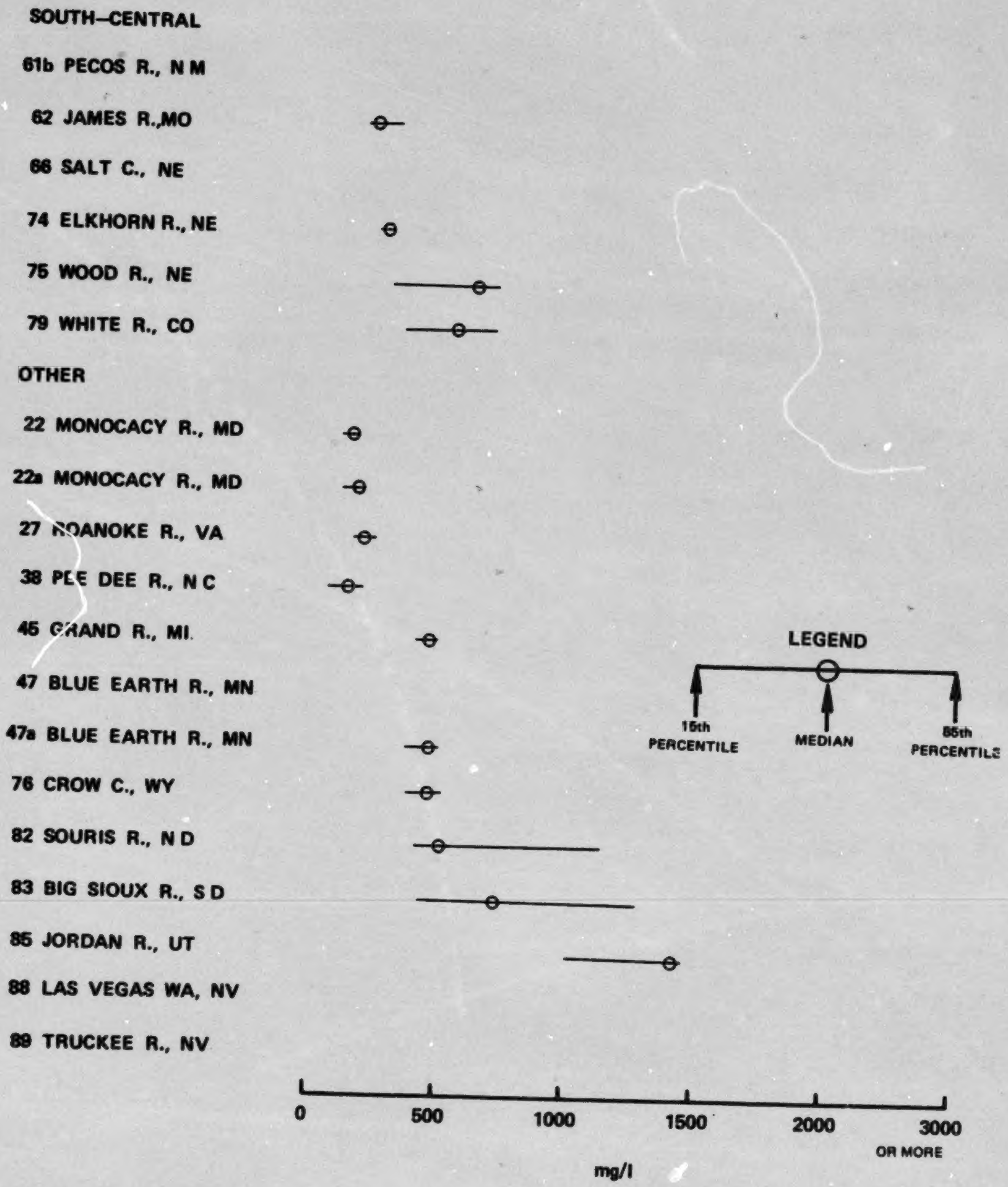


Figure A-49

## CHLORIDE CONCENTRATIONS
## FOR
## STATIONS ON SMALL STREAMS
## 1974

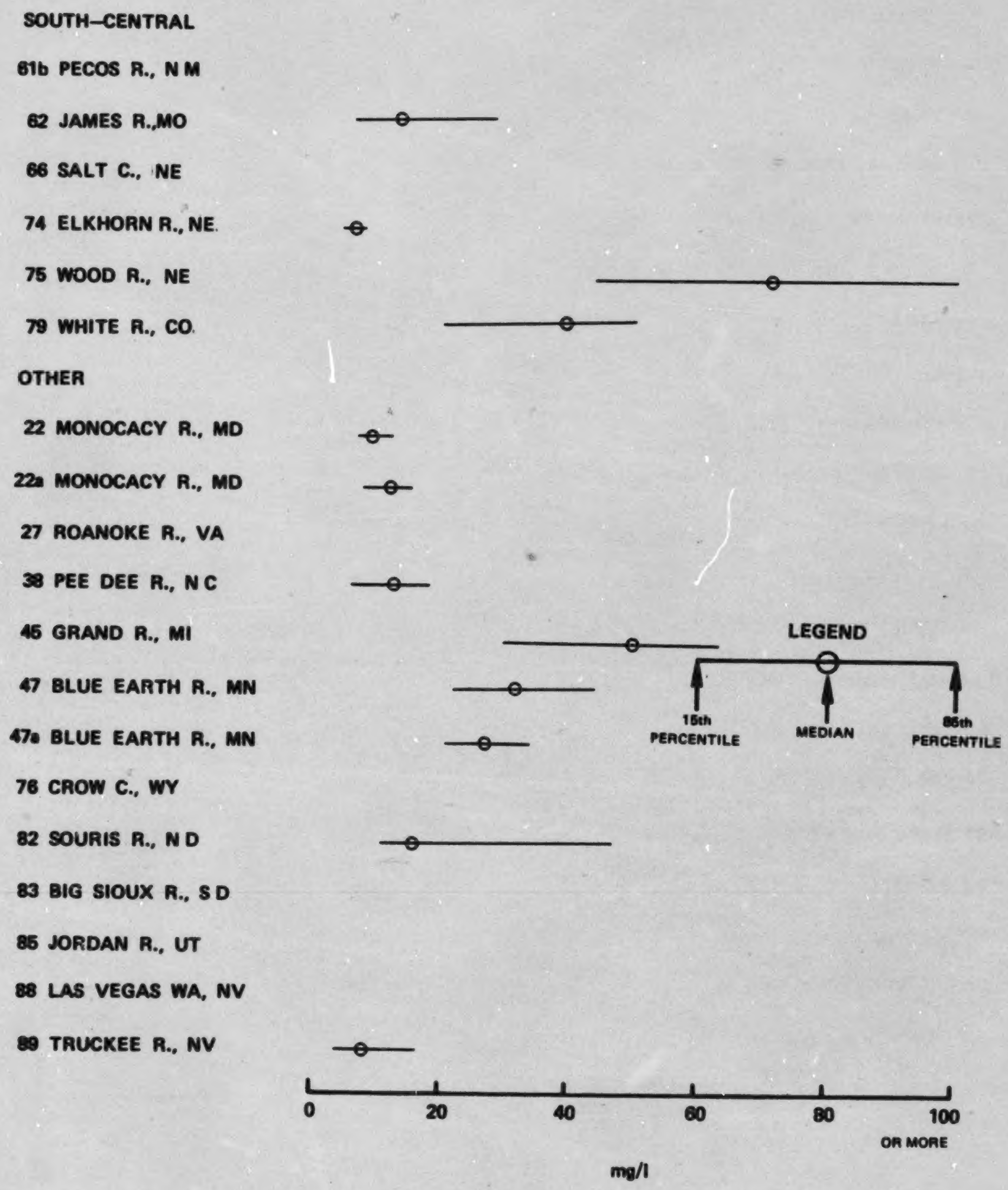


Figure A-50

## TOTAL SULFATE CONCENTRATIONS
## FOR
## STATIONS ON SMALL STREAMS
## 1974

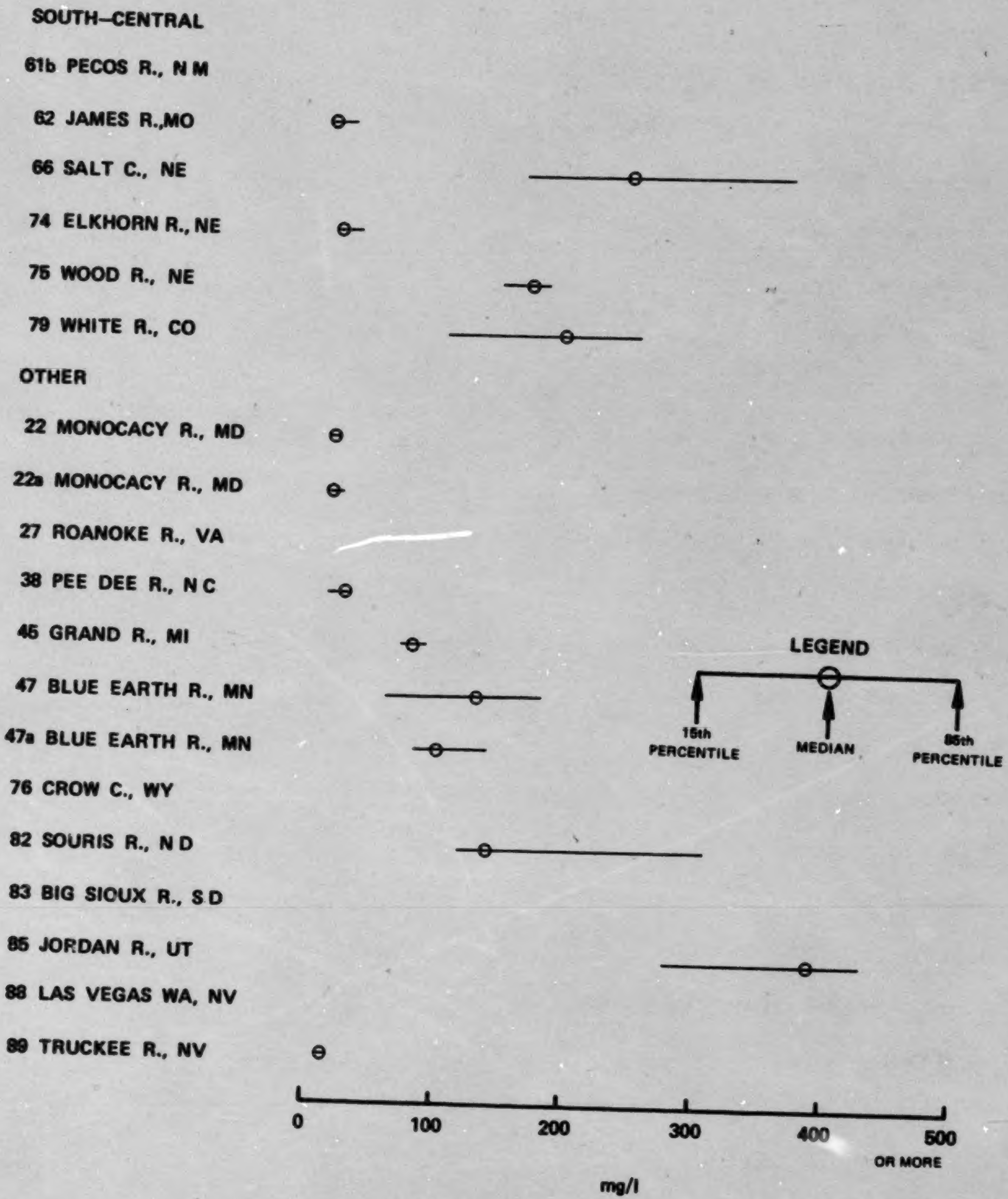


Figure A-51

TOTAL AMMONIA CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

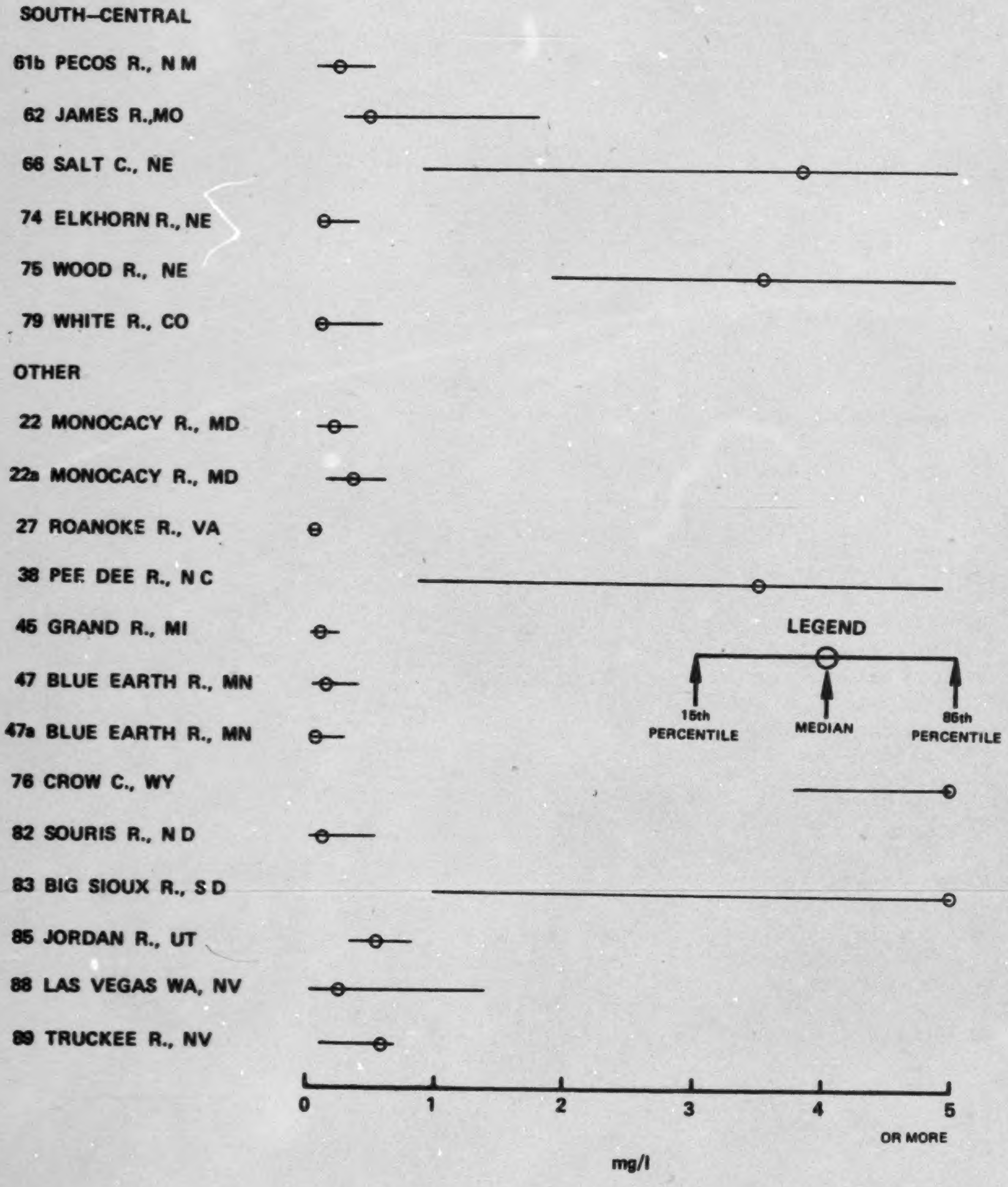


Figure A-52

TOTAL KJELDAHL NITROGEN CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

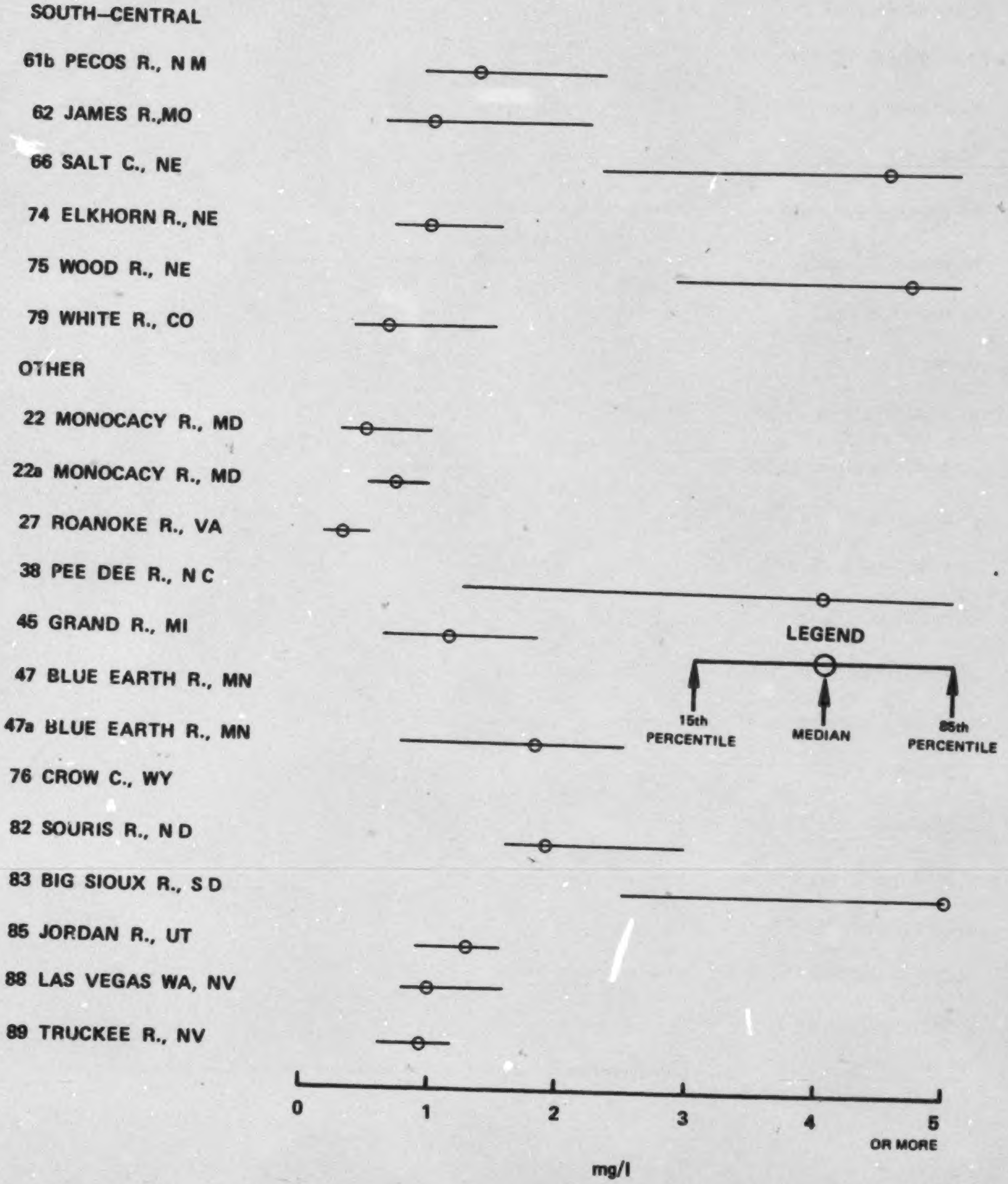


Figure A-53

TOTAL NITRATE PLUS NITRITE CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

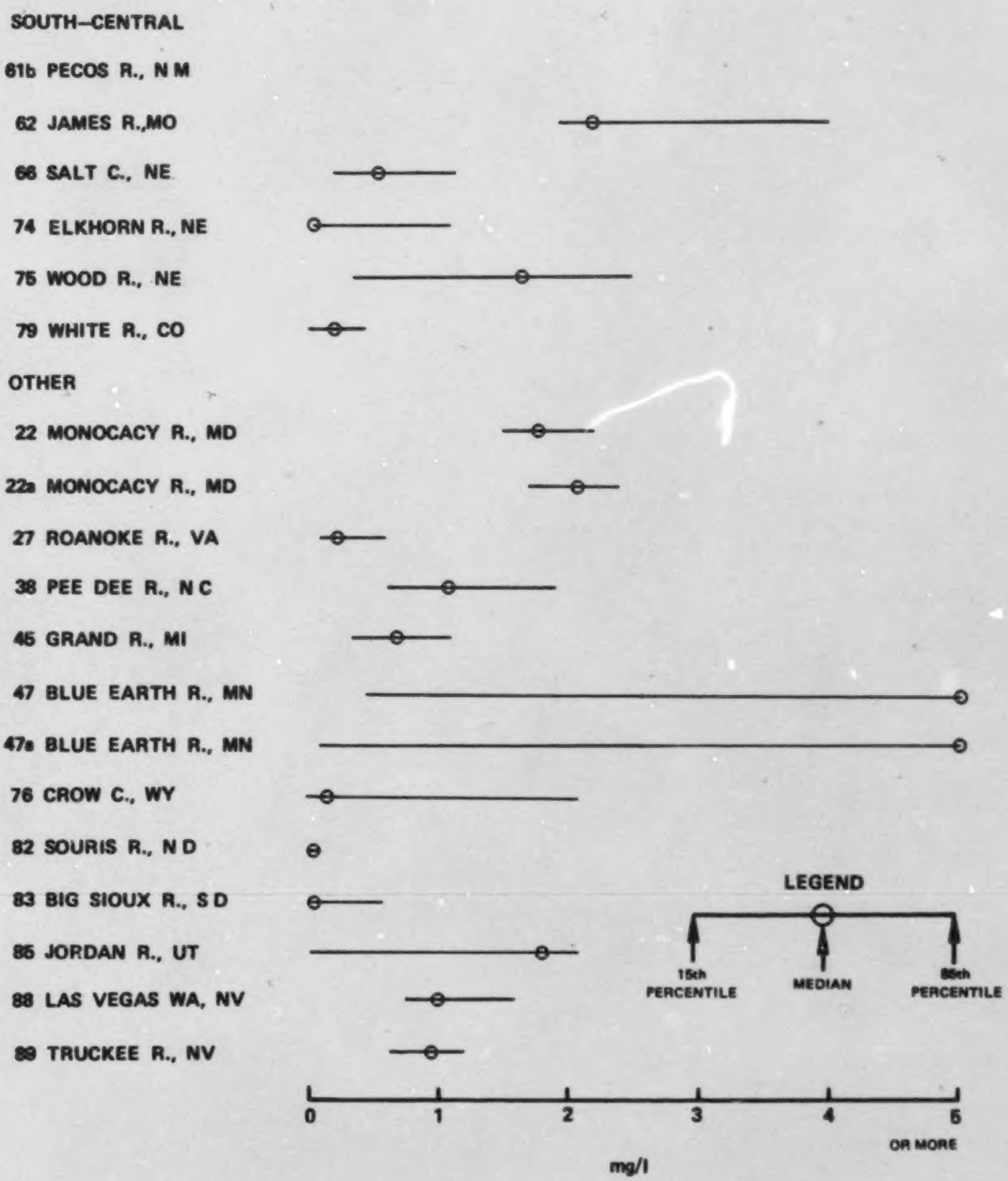


Figure A-54

TOTAL PHOSPHORUS CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

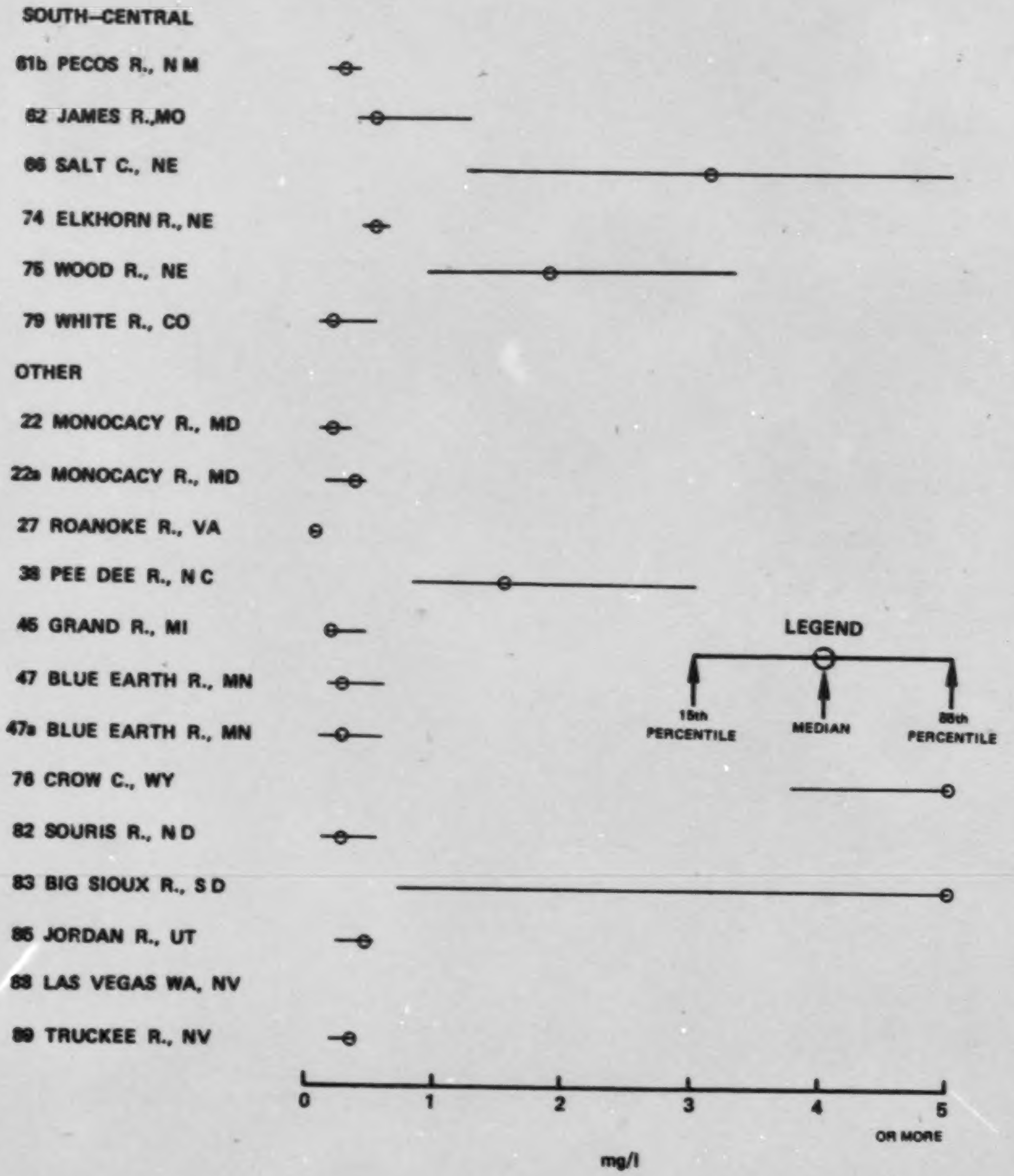


Figure A-55

DISSOLVED OXYGEN CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

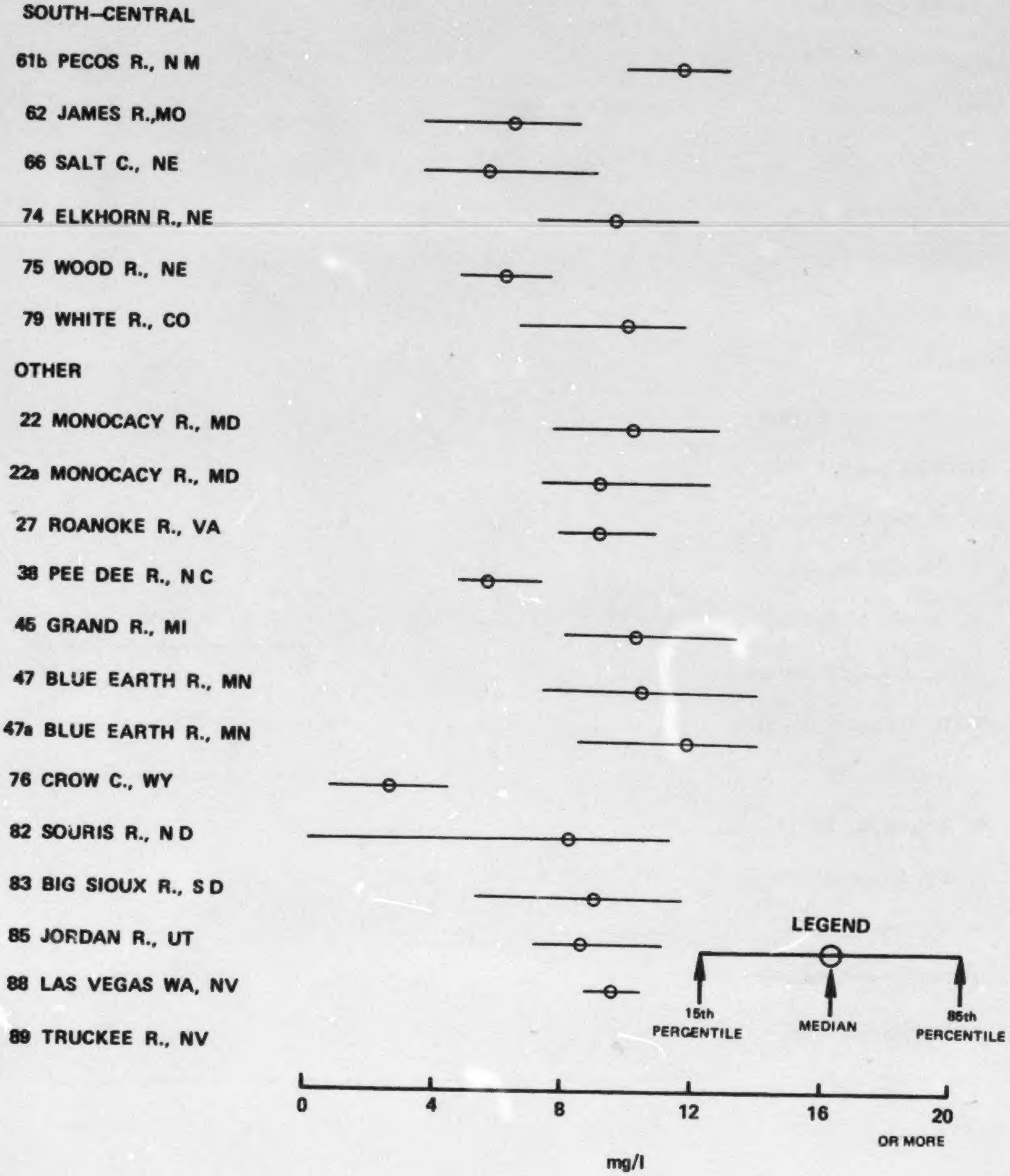


Figure A-56

CHEMICAL OXYGEN DEMAND
FOR
STATIONS ON SMALL STREAMS

1974

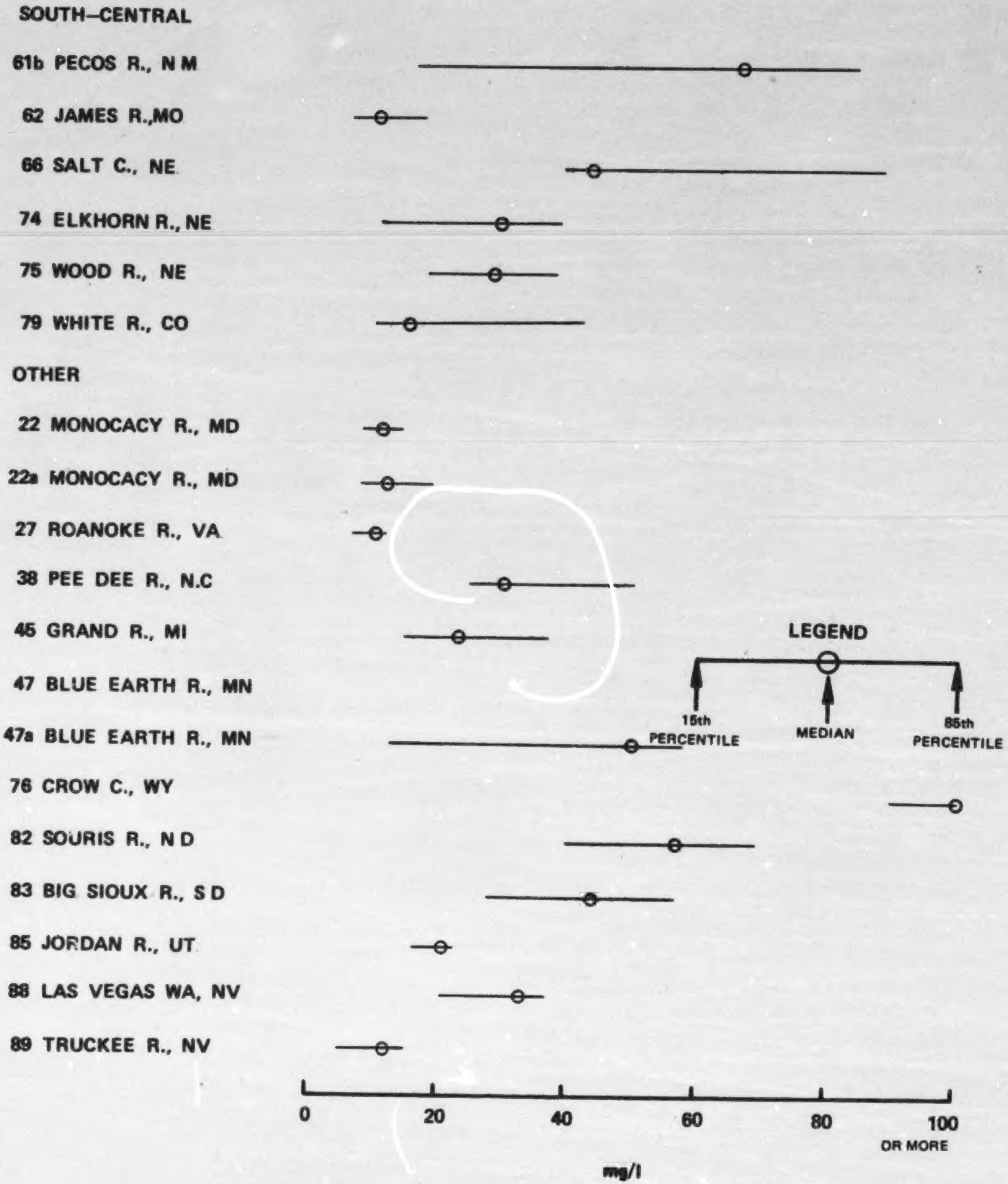


Figure A-57

TOTAL ORGANIC CARBON CONCENTRATIONS
FOR
STATIONS ON SMALL STREAMS
1974

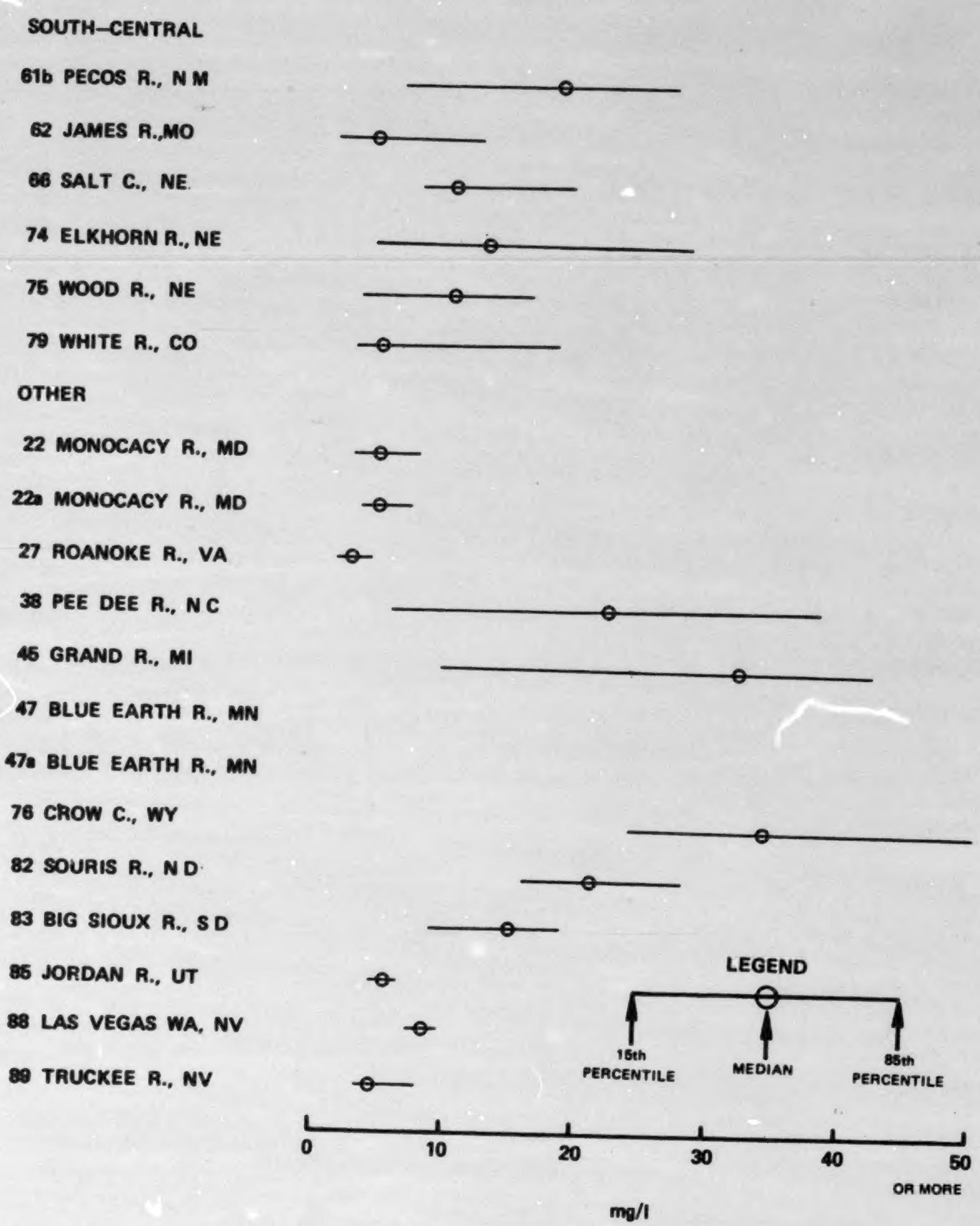
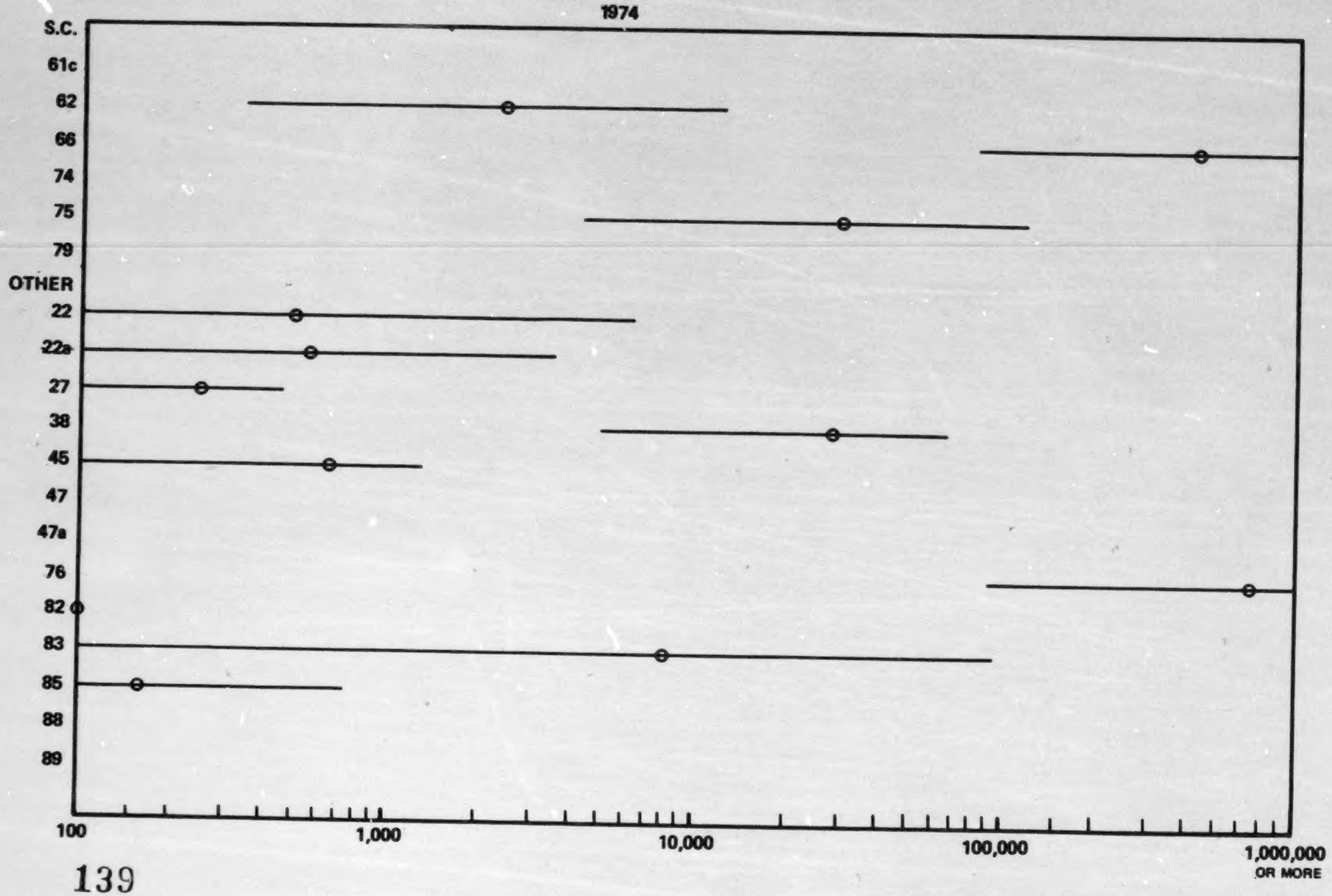


Figure A-58

## FECAL COLIFORM BACTERIA LEVELS FOR STATIONS ON SMALL STREAMS 1974



# APPENDIX B

# National Eutrophication Survey

Appendix B provides a listing of the water quality characteristics which were measured to determine the condition of the lakes studied in the survey (Table B-1). A listing of the lakes for which a detailed analysis of phosphorus loading rates were determined is also provided. The lakes are separated into those impacted by municipal treatment plants (Table B-2) and those not impacted by any identifiable point sources (Table B-3).

## Selection Criteria

Freshwater lakes and impoundments in NES were selected jointly by EPA headquarters, EPA regional offices, and State pollution control agencies, as well as related state agencies managing fisheries, water resources, or public health. EPA established selection criteria to limit the type and number of candidate water bodies, consistent with existing EPA water goals and strategies. For 27 States in the eastern United States, selected prior to passage of the Act, strongest emphasis was placed on lakes faced with actual or potential accelerated eutrophication problems. As a result, the lakes selected were 100 acres or larger in size, had mean hydraulic retention times of at least 30 days, and were impacted by one or more municipal sewage treatment plants, either directly or by discharge to an inlet tributary within approximately 25 miles of the lake. However, these criteria were waived for a number of lakes of particular interest to the States.

In the western States, these criteria were modified to reflect revised water research mandates, and to address more prevalent nonpoint source problems in agricultural or undeveloped areas. Thus, each State was requested to submit a list of candidate lakes that were representative of the full range of water quality, were in the recreational, water supply, and/or fish and wildlife propagation use-categories, and were representative of the full scope of nutrient pollution problems or sources (from municipal waste and/or nutrient-rich industrial discharges, as well as from nonpoint sources). The size and retention time criteria applied in the eastern States were retained, as was the waiver provision.

In all cases, listings of potential candidate lakes or reservoirs, prepared with the cooperation of the EPA Regional Offices, were made available to the States to initiate the selection process.

In total, the survey will have covered 812 lakes and reservoirs across the contiguous 48 United States when it is completed in 1976.

TABLE B-1

WATER QUALITY CHARACTERISTICS MEASURED IN NATIONAL EUTROPHICATION SURVEY

| | |
|---|---|
| Physical-chemical | Alkalinity<br>Conductivity*<br>pH*<br>Dissolved oxygen*<br>Phosphorus:<br>Ortho<br>Total<br>Nitrogen:<br>Ammonia<br>Kjeldahl<br>Nitrate<br>Secchi depth<br>Temperature* |
| Biological | Algal assay<br>Algal count and identification<br>Chlorophyll a |

*Determined on site with electronic probes.

## TABLE B-2

## TOTAL PHOSPHORUS LOADINGS, TROPHIC CONDITION, AND LIMITING NUTRIENT FOR WATER BODIES IN FIGURE VI-5

| Water body | STORET number | Trophic condition* | Limiting nutrient | Vollenweider factor | Total phosphorus loadings (g/m²/yr) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Existing | With 50% STP reduction | With 80% STP reduction |
| **Connecticut** | | | | | | | |
| Bantam Lake | 0902 | E | N | 14.3 | 0.63 | 0.60 | 0.59 |
| Eagleville Lake | 0904 | E | P | 450.0 | 54.06 | 36.48 | 25.97 |
| Lake Zoar | 0910 | E | P | 535.7 | 39.22 | 37.94 | 37.16 |
| Lake Lillinonah | 0911 | E | P | 253.2 | 29.08 | 27.15 | 25.99 |
| **Georgia** | | | | | | | |
| Alltoona Reservoir | 1301 | M | P | 33.3 | 2.09 | 1.82 | 1.66 |
| Blackshear Lake | 1302 | E | P | 129.3 | 9.57 | 9.12 | 8.85 |
| Chatuge Lake | 1303 | M | P | 13.2 | 0.38 | 0.37 | 0.37 |
| Clark Hill Reservoir | 1304 | M | P | 30.4 | 1.61 | 1.55 | 1.52 |
| Jackson Lake | 1309 | E | P | 81.2 | 33.38 | 22.28 | 15.64 |
| Sidney Lanier Lake | 1310 | M | P | 12.2 | 1.20 | 0.89 | 0.88 |
| Nottely Reservoir | 1311 | M | P | 20.7 | 0.75 | 0.73 | 0.72 |
| Seminole Lake | 1312 | E | P | 136.4 | 8.82 | 8.70 | 8.63 |
| Sinclair Lake | 1313 | E | P | 45.5 | 4.10 | 3.99 | 3.93 |
| Walter F. George Reservoir | 1314 | E | P | 48.1 | 4.55 | 3.67 | 3.14 |
| Harding Lake | 1317 | E | P | 247.4 | 58.74 | 58.10 | 57.72 |
| High Falls Pond | 1319 | E | P | 97.4 | 8.07 | 5.50 | 3.95 |
| **Maine** | | | | | | | |
| Estes Lake | 2304 | E | N | 100.0 | 9.65 | 6.06 | 3.91 |
| Mattawamkeag Lake | 2308 | M | N | 32.2 | 0.59 | 0.43 | 0.34 |
| Rangeley Lake | 2310 | O | P | 55.1 | 0.09 | 0.08 | 0.08 |
| Sebasticook Lake | 2312 | E | N | 10.6 | 0.68 | 0.44 | 0.30 |
| Long Lake | 2313 | M | P | 4.2 | 0.12 | 0.11 | 0.11 |
| **Massachusetts** | | | | | | | |
| Hager Pond | 2502 | E | P | 22.7 | 129.68 | 65.43 | 26.87 |
| Harris Pond | 2503 | E | P | 141.2 | 10.84 | 7.41 | 5.35 |
| Maynard Impoundment | 2504 | E | N | 400.0 | 128.02 | 72.26 | 38.80 |
| **Michigan** | | | | | | | |
| Lake Allegan | 2603 | E | P | 178.9 | 31.40 | 27.74 | 25.54 |
| Barton Lake | 2606 | E | P | 27.5 | 2.14 | 1.42 | 1.01 |
| Belleville Lake | 2609 | E | P | 89.7 | 15.74 | 8.36 | 3.94 |
| Ford Lake | 2629 | E | P | 107.3 | 16.16 | 8.70 | 4.21 |
| Freemont Lake | 2631 | E | N | 5.3 | 2.97 | 2.34 | 1.96 |
| Jordan Lake | 2640 | E | P | 8.8 | 1.14 | 1.06 | 1.02 |
| Kent Lake | 2643 | E | P | 22.2 | 1.59 | 1.16 | 0.90 |
| Macatawa Lake | 2648 | E | P | 17.5 | 6.34 | 4.60 | 3.56 |
| Muskegon Lake | 2659 | E | N | 111.1 | 6.86 | 5.65 | 4.92 |
| Randall Lake | 2671 | E | N | 48.2 | 4.00 | 2.88 | 2.22 |
| Ross Reservoir | 2673 | E | P | 300.0 | 17.02 | 15.68 | 14.88 |
| Thornapple Lake | 2683 | E | P | 143.3 | 9.23 | 8.92 | 8.75 |
| Union Lake | 2685 | E | P | 180.0 | 9.29 | 9.13 | 9.05 |
| White Lake | 2688 | E | P | 45.1 | 1.98 | 1.84 | 1.76 |
| Mona Lake | 2691 | E | N | 19.2 | 9.63 | 7.30 | 5.91 |
| Long Lake | 2692 | E | N | 61.2 | 4.61 | 2.85 | 1.82 |
| Houghton Lake | 2696 | M | P | 1.8 | 0.05 | 0.05 | 0.04 |
| Strawberry Lake | 2699 | E | P | 186.1 | 9.18 | 8.42 | 8.01 |

## TABLE B-2 (Continued)

## TOTAL PHOSPHORUS LOADINGS, TROPHIC CONDITION, AND LIMITING NUTRIENT FOR WATER BODIES IN FIGURE VI-5

| Water body | STORET number | Trophic condition* | Limiting nutrient | Vollenweider factor | Total phosphorus loadings ($g/m^2/yr$) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Existing | With 50% STP reduction | With 80% STP reduction |
| **Minnesota** | | | | | | | |
| Lake Winona | 27A1 | E | N | 0.9 | 1.65 | 0.84 | 0.37 |
| Wolf Lake | 27A2 | E | N | 84.2 | 6.43 | 4.84 | 3.90 |
| Lake Pepin | 27A4 | E | N | 204.0 | 34.38 | 27.99 | 24.16 |
| Spring Lake | 27A6 | E | N | 342.9 | 107.15 | 80.69 | 64.82 |
| Lake St. Croix | 27A7 | E | P | 139.7 | 8.89 | 8.37 | 8.07 |
| Wagonga Lake | 27B1 | E | N | 0.9 | 4.00 | 2.12 | 1.00 |
| Green Lake | 27B2 | M | P | 1.7 | 0.09 | 0.07 | 0.06 |
| Nest Lake | 27B3 | E | N | 8.8 | 0.79 | 0.56 | 0.43 |
| Lake Le Homme Dieu | 27B5 | E | P | 0.8 | 0.11 | 0.08 | 0.07 |
| Lake Carlos | 27B9 | M | P | 3.5 | 0.14 | 0.11 | 0.13 |
| Lake Andrusia | 27C0 | E | P | 61.2 | 4.02 | 3.04 | 2.46 |
| Mud Lake | 27C2 | E | N | 1.9 | 4.96 | 2.51 | 1.04 |
| Albert Lea Lake | 2702 | E | N | 5.5 | 6.31 | 3.67 | 2.09 |
| Badger Lake | 2704 | E | P | 4.1 | 0.63 | 0.41 | 0.27 |
| Bartlett Lake | 2705 | E | P | 1.4 | 0.37 | 0.21 | 0.11 |
| Blackduck Lake | 2711 | E | P | 1.1 | 0.14 | 0.11 | 0.09 |
| Blackhoof Lake | 2712 | E | N | 6.3 | 1.22 | 0.78 | 0.53 |
| Buffalo Lake | 2713 | E | N | 3.1 | 0.98 | 0.58 | 0.35 |
| Cass Lake | 2715 | M | P | 8.9 | 0.35 | 0.28 | 0.24 |
| Clearwater Lake | 2716 | E | N | 3.7 | 0.67 | 0.66 | 0.48 |
| Cokato Lake | 2719 | E | N | 6.7 | 2.60 | 2.24 | 2.03 |
| Elbow Lake | 2725 | E | N | 3.8 | 7.87 | 4.00 | 1.68 |
| Embarrass Lake | 2728 | E | P | 43.3 | 1.70 | 1.29 | 1.04 |
| Fanny Lake | 2731 | E | N | 9.7 | 14.96 | 12.69 | 11.33 |
| Heron Lake | 2739 | E | N | 2.4 | 1.04 | 0.83 | 0.70 |
| Leech Lake | 2746 | M | P | 0.9 | 0.37 | 0.35 | 0.34 |
| Lily Lake | 2747 | E | N | 16.4 | 6.58 | 4.81 | 3.74 |
| Malmedal Lake | 2752 | E | P | 1.4 | 0.28 | 0.19 | 0.14 |
| Mashkenode Lake | 2756 | E | N | 19.1 | 5.38 | 3.01 | 1.60 |
| McQuade Lake | 2757 | E | N | 17.3 | 1.20 | 0.92 | 0.75 |
| Lake Minnewaska | 2761 | E | P | 0.5 | 0.15 | 0.09 | 0.07 |
| Pelican Lake | 2765 | M | P | 0.8 | 0.06 | 0.05 | 0.05 |
| Upper Sakatah Lake | 2777 | E | N | 17.4 | 3.74 | 3.62 | 3.55 |
| Silver Lake | 2782 | E | N | 0.5 | 0.53 | 0.30 | 0.16 |
| Six Mile Lake | 2783 | E | N | 19.2 | 5.09 | 2.83 | 1.48 |
| Swan Lake | 2788 | M | P | 5.0 | 0.57 | 0.41 | 0.33 |
| Trout Lake | 2793 | E | N | 0.9 | 0.33 | 0.18 | 0.10 |
| **New Hampshire** | | | | | | | |
| Powder Mill Pond | 3302 | E | P | 138.9 | 3.25 | 2.40 | 1.90 |
| Lake Winnipesaukee | 3303 | O | P | 3.3 | 0.12 | 0.09 | 0.08 |
| Kellys Falls Pond | 3305 | E | P | 575.0 | 28.77 | 25.62 | 23.82 |
| Glen Lake | 3306 | E | P | 425.0 | 13.13 | 9.81 | 7.85 |
| **New York** | | | | | | | |
| Canandaigua | 3604 | O | P | 2.6 | 0.14 | 0.11 | 0.09 |
| Cayuga Lake | 3608 | M | P | 4.9 | 0.49 | 0.38 | 0.32 |
| Chautauqua | 3610 | E | N | 4.9 | 0.27 | 0.20 | 0.16 |
| Cross Lake | 3611 | E | P | 289.5 | 33.52 | 30.17 | 28.16 |
| Raquette Pond | 3629 | E | P | 63.6 | 0.99 | 0.94 | 0.91 |

## TABLE B-2 (Continued)

## TOTAL PHOSPHORUS LOADINGS, TROPHIC CONDITION, AND LIMITING NUTRIENT FOR WATER BODIES IN FIGURE VI-5

| | | | | | Total phosphorus loadings ($g/m^2/yr$) | | |
|---|---|---|---|---|---|---|---|
| Water body | STORET number | Trophic condition* | Limiting nutrient | Vollenweider factor | Existing | With 50% STP reduction | With 80% STP reduction |
| **New York (Continued)** | | | | | | | |
| Saratoga Lake | 3633 | E | P | 19.2 | 1.60 | 1.19 | 0.95 |
| Seneca Lake | 3635 | M | P | 2.6 | 0.38 | 0.24 | 0.17 |
| Swinging Bridge Reservoir | 3637 | E | P | 53.2 | 7.07 | 4.23 | 2.53 |
| Lower St. Regis | 3640 | E | P | 16.9 | 0.41 | 0.38 | 0.37 |
| **Rhode Island** | | | | | | | |
| Slattersville Reservoir | 4402 | E | P | 171.4 | 5.61 | 5.14 | 4.88 |
| Turner Reservoir | 4403 | E | N | 166.7 | 162.98 | 133.48 | 114.19 |
| **South Carolina** | | | | | | | |
| Fishing Creek Reservoir | 4503 | E | P | 304.0 | 52.94 | 47.89 | 44.85 |
| Greenwood Lake | 4504 | E | P | 33.8 | 8.97 | 5.38 | 3.23 |
| Hartwell Reservoir | 4505 | M | P | 15.2 | 0.78 | 0.69 | 0.64 |
| Marion Lake | 4506 | E | P | 33.1 | 3.54 | 3.53 | 3.53 |
| Robinson Lake | 4508 | E | P | 22.7 | 0.49 | 0.36 | 0.29 |
| Wateree Lake | 4510 | E | P | 93.2 | 11.08 | 11.01 | 10.98 |
| Wylie Lake | 4511 | E | P | 65.4 | 7.53 | 6.02 | 5.13 |
| Keowee Lake | 4513 | M | P | 13.8 | 0.29 | 0.27 | 0.26 |
| **Vermont** | | | | | | | |
| Clyde Pond | 5002 | E | P | 340.0 | 8.31 | 7.53 | 7.08 |
| Harriman Reservoir | 5005 | M | P | 48.6 | 0.88 | 0.75 | 0.70 |
| Lake Lamoille | 5007 | E | P | 566.7 | 25.21 | 21.53 | 19.33 |
| Lake Memphremagog | 5008 | E | P | 9.1 | 0.50 | 0.40 | 0.34 |
| Arrowhead Mountain Lake | 5010 | E | P | 310.0 | 11.26 | 10.15 | 9.48 |
| Waterbury Reservoir | 5011 | M | P | 55.9 | 1.34 | 1.08 | 0.92 |
| **Wisconsin** | | | | | | | |
| Altoona Lake | 5502 | E | N | 150.0 | 19.90 | 19.76 | 19.68 |
| Lake Butte Des Morts | 5508 | E | N | 112.5 | 9.61 | 9.55 | 9.51 |
| Butternut Lake | 5509 | E | N | 10.8 | 0.64 | 0.52 | 0.46 |
| Delavan Lake | 5513 | E | N | 2.7 | 1.12 | 0.68 | 0.44 |
| Eau Claire Lake | 5515 | E | N | 85.2 | 9.04 | 8.45 | 8.10 |
| Kegonsa Lake | 5520 | E | N | 13.9 | 1.85 | 1.82 | 1.81 |
| Koshkonong Lake | 5522 | E | N | 24.2 | 9.87 | 9.08 | 8.60 |
| Nagawicka Lake | 5531 | E | N | 6.6 | 1.33 | 0.93 | 0.72 |
| Pigeon Lake | 5535 | E | N | 75.0 | 6.45 | 5.42 | 4.82 |
| Lake Poygan | 5538 | E | N | 58.3 | 5.55 | 5.53 | 5.51 |
| Sinissippi Lake | 5541 | E | N | 15.6 | 6.35 | 6.00 | 5.79 |
| Swan Lake | 5545 | E | N | 19.9 | 2.78 | 2.25 | 1.95 |
| Tainter Lake | 5546 | E | N | 151.9 | 20.30 | 20.22 | 20.17 |
| Townline Lake | 5548 | E | N | 5.4 | 1.40 | 1.00 | 0.80 |
| Wapogasset Lake | 5550 | E | P | 9.9 | 0.71 | 0.63 | 0.59 |
| Wausau Lake | 5551 | E | P | 440.0 | 28.40 | 25.02 | 22.99 |
| Lake Winnebago | 5554 | E | N | 6.9 | 0.94 | 0.84 | 0.78 |
| Wisconsin Lake | 5555 | E | N | 163.6 | 15.21 | 14.92 | 14.75 |
| Lake Wissota | 5556 | E | N | 161.7 | 7.64 | 7.57 | 7.53 |
| Tichigan Lake | 5559 | E | N | 36.5 | 20.51 | 11.92 | 6.79 |
| Big Eau Pleine Reservoir | 5565 | E | N | 11.1 | 1.49 | 1.47 | 1.46 |

### TABLE B-2 (Continued)

### TOTAL PHOSPHORUS LOADINGS, TROPHIC CONDITION, AND LIMITING NUTRIENT FOR WATER BODIES IN FIGURE VI-5

| Water body | STORET number | Trophic condition* | Limiting nutrient | Vollenweider factor | Total phosphorus loadings (g/m$^2$/yr) Existing | With 50% STP reduction | With 80% SPT reduction |
|---|---|---|---|---|---|---|---|
| **Wisconsin (Continued)** | | | | | | | |
| Rome Pond | 5568 | E | N | 37.5 | 3.36 | 3.22 | 3.14 |
| Grand Lake | 5570 | E | P | 40.0 | 8.57 | 7.69 | 7.18 |
| Elk Lake | 5575 | E | P | 360.0 | 18.39 | 16.01 | 14.59 |
| Beaverdam Lake | 5577 | E | N | 3.4 | 0.88 | 0.82 | 0.78 |

* E = eutrophic
M = mesotrophic
O = oligotrophic

## TABLE B-3

## TOTAL PHOSPHORUS LOADINGS, TROPHIC CONDITION, AND LIMITING NUTRIENT FOR WATER BODIES IN FIGURE VI-6

| Water body | STORET number | Trophic condition | Limiting nutrient | Vollenweider factor | Total phosphorus loading ($g/m^2/yr$) |
|---|---|---|---|---|---|
| Georgia | | | | | |
| Blue Ridge lake | 1316 | M | P | 38.17 | 0.91 |
| Burton Lake | 1318 | M | P | 26.98 | 0.04 |
| Maine | | | | | |
| Moosehead Lake | 2309 | O | P | 5.50 | 0.08 |
| Sebago Lake | 2311 | O | P | 5.70 | 0.08 |
| Bay of Naples | 2314 | O | P | 60.56 | 0.51 |
| Michigan | | | | | |
| Lake Chemung | 2618 | E | P | 2.02 | 0.22 |
| Sanford Lake | 2674 | E | P | 120.00 | 3.92 |
| Crystal Lake | 2694 | O | P | 1.27 | 0.07 |
| Higgins Lake | 2695 | O | P | 0.96 | 0.03 |
| Thompson Lake | 2697 | E | P | 6.49 | 0.41 |
| Minnesota | | | | | |
| Budd Lake | 27A8 | E | N | 10.23 | 1.70 |
| Forest Lake | 27A9 | E | P | 0.60 | 0.38 |
| Darling Lake | 27B4 | M | P | 7.12 | 0.19 |
| Lake Bemidji | 27C1 | E | N | 13.35 | 0.44 |
| Madison Lake | 2750 | E | P | 1.21 | 0.36 |
| New York | | | | | |
| Carry Falls Reservoir | 3606 | M | P | 51.92 | 0.71 |
| Keuka Lake | 3617 | M | P | 2.90 | 0.10 |
| Schroon Lake | 3634 | O | P | 34.13 | 0.39 |
| Conesus Lake | 3639 | E | N | 5.24 | 0.38 |
| South Carolina | | | | | |
| Moultrie Lake | 4512 | E | P | 52.73 | 2.47 |
| Saluda Lake | 4515 | E | P | 400.00 | 16.94 |
| Wisconsin | | | | | |
| Shawano Lake | 5539 | E | P | 2.13 | 0.07 |
| Willow Lake | 5574 | M | N | 14.11 | 0.44 |

# APPENDIX C

# State Agency Addresses

Chapters 1 through 4 are based almost exclusively on information provided by the States in their 1975 water quality inventory reports. Copies of these reports are available directly from the State agencies listed below.

## Region I

### Connecticut

Division of Water Compliance and Hazardous Substances
Department of Environmental Protection
165 Capitol Avenue
Hartford, CT 06115

### Maine

Division of Water Quality Evaluation and Planning
Bureau of Water Quality Control
Department of Environmental Protection
Statehouse
Augusta, ME 04330

### New Hampshire

Water Supply and Pollution Control Commission
105 Loudon Road
Prescott Park
Concord, NH 03301

### Rhode Island

Division of Water Supply and Pollution Control
Rhode Island Department of Health
State Office Building
Davis Street
Providence, RI 02908

### Vermont

Department of Water Resources
Agency of Environmental Conservation
State Office Building
Montpelier, VT 05602

## Region II

### New York

Division of Pure Waters
New York State Department of Environmental Conservation
Albany, NY 12301

### New Jersey

New Jersey Department of Environmental Protection
P.O. Box 1390
Trenton, NJ 08625

### Puerto Rico

Environmental Quality Board
1550 Ponce de Leon Avenue
Santurce, PR 00910

### Virgin Islands

Division of Natural Resources Management
Department of Conservation and Cultural Affairs
Charlotte Amalie, St. Thomas, VI 00801

## Region III

### Delaware

Division of Environmental Control
Department of Natural Resources and Environmental Control
Tatnall Building, Capitol Complex
Dover, DE 19901

### Maryland

Maryland Environmental Service
Tawes State Office Building
Annapolis, MD 21404

### District of Columbia

Department of Environmental Services
Water Resources Management Administration
415-12th St. NW Room 307
Washington, D.C. 20004

### Pennsylvania

Pennsylvania Department of Environmental Resources
Bureau of Water Quality Management
P.O. Box 1063
Harrisburg, PA 17120

Virginia

Virginia State Water Control Board
P.O. Box 11143
Richmond, VA 23230

West Virginia

Division of Water Resources
Department of Natural Resources
1201 Greenbrier Street
Charleston, WV 25311

J. Marion Sims Building
2600 Bull St.
Columbia, SC 29201

Tennessee

Tennessee Division of Water Quality Control
Department of Public Health
621 Cordell Hull Building
Nashville, TN 37219

## Region IV

Alabama

Alabama Water Improvement Commission
State Office Building
Montgomery, AL 36104

Florida

Department of Pollution Control
2562 Executive Center Circle
Tallahassee, FL 32301

Georgia

Environmental Protection Division
Department of Natural Resources
270 Washington St., S.W.
Atlanta, GA 30334

Kentucky

Division of Water Quality
Department for Natural Resources and Environmental Protection
275 East Maine Street
Frankfort, KY 40601

North Carolina

Division of Environmental Management
Department of Natural and Economic Resources
Raleigh, NC 27611

South Carolina

Department of Health and Environmental Control

## Region V

Illinois

Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, IL 62706

Indiana

Water Pollution Control Division
Indiana State Board of Health
1330 West Michigan Street
Indianapolis, IN 46206

Michigan

Bureau of Water Management
Department of Natural Resources
Stevens T. Mason Building
Lansing, MI 48926

Minnesota

Division of Water Quality
Minnesota Pollution Control Agency
1935 West County Road B-2
Roseville, MN 55113

Ohio

Ohio Environmental Protection Agency
P.O. Box 118
Columbus, OH 43215

Wisconsin

Department of Natural Resources
P.O. Box 450
Madison, WI 53701

Region VI

Arkansas

Arkansas Department of Pollution Control and Ecology
8001 National Drive
Little Rock, AR 72209

Louisiana

Louisiana Stream Control Commission
P.O. Drawer FC, University Station
Baton Rouge, LA 70803

New Mexico

Water Quality Section
Environmental Improvement Agency
P.O. Box 2348
Santa Fe, NM 87501

Oklahoma

Department of Pollution Control
Box 53504
N.E. 10th & Stonewall
Oklahoma City, OK 73105

Texas

Texas Water Quality Board
Administrative Operations Division
P.O. Box 13246, Capitol Station
Austin, TX 78711

Region VII

Iowa

Iowa Department of Environmental Quality
3920 Delaware Avenue
P.O. Box 3326
Des Moines, IA 50316

Kansas

Division of Environment
Department of Health and Environment
Topeka, KS 66620

Missouri

Clean Water Commission
Capital Bldg., Box 154
Jefferson City, MO 65101

Nebraska

Water Quality Section
Water Pollution Control Division
Department of Environmental Control
P.O. Box 94653
State House Station
Lincoln, NB 68509

Region VIII

Colorado

Water Quality Control Division
Colorado Department of Health
4210 East 11th Avenue
Denver CO 80220

Montana

Water Quality Bureau
Environmental Sciences Division
Department of Health and Environmental Sciences
Cogswell Building
Helena, MT 59601

North Dakota

Division of Water Supply and Pollution Control
Department of Health
Bismarck, ND 58505

South Dakota

Department of Environmental Protection
Pierre, SD 57501

Utah

Bureau of Water Quality
Environmental Health Services Branch
Division of Health
Department of Social Services
221 State Capitol
Salt Lake City, UT 84114

Wyoming

Water Quality Division
Department of Environmental Quality
State Office Building West
Cheyenne, WY 82002

Region IX

American Samoa

American Samoa Environmental Quality Commission
Office of the Governor
Pago Pago, American Samoa 96799

Arizona

Bureau of Water Quality Control
Division of Environmental Health Services
Arizona Department of Health Services
1740 West Adams St.
Phoenix, AZ 85007

California

California State Water Resources Control Board
1416 Ninth St.
Sacramento, CA 95814

Hawaii

Environmental Health Division
Department of Health
P.O. Box 3378
Honolulu, HI 96801

Guam

Guam Environmental Protection Agency
Box 2999
Agana, Guam 96910

Nevada

Environmental Protection Section
Department of Human Resources
1209 Johnson St.
Carson City, NV 89701

Trust Territories of the Pacific Islands

Division of Environmental Health
Department of Health Services
Trust Territory of the Pacific Islands
Saipan, Mariana Islands 96950

Region X

Idaho

Department of Health and Welfare
Statehouse
Boise, ID 83720

Oregon

Oregon Department of Environmental Quality
1234 W. Morrison St.
Portland, OR 97205

Washington

Department of Ecology
P.O. Box 820
Olympia, WA 98504

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